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Self-Ballasted Lamps and Lamp Adapters

May 17, 2024

Approved American National Standard

ANSI/UL 1993-2024

Standard for Safety for Self-Ballasted Lamps and Lamp Adapters

Fourth Edition, Dated May 17, 2024

Summary of Topics

This new Fourth Edition dated May 17, 2024 includes the following changes in requirements:

– Flammability rating of polymeric lamp bases
– Additional instructions for Type A LED lamps
– Revision to A8.8 Drop Impact Test
–Alternate wattage limit for high-lumen lamps
– Revisions to production line test conditions
– Lamps for use in elevated ambient temperatures
– Merging of duplicate rigidity after drop test methods
– Protective functions during the temperature test
– Wireless control circuits
– LED Lamps – Current Cascade Abnormal
– Edison screw base length
– Correction of footnote b in Table 5.2
– Corrections to various errors
– Updates to ANCE references – 2.1
– 4.5.1.2: Add the reference – NMX-J-198-ANCE-2015
– 5.3.1: Add the publication year to the reference NMX-565/2-11-ANCE
– 5.3.3: Add the reference NMX-J-565/3-ANCE-2006
– Table 5.2 – Add a note; updates to footnote b and footnote c
– 5.4.5: update reference to: NMX-J-024-ANCE-2018
– 6.1.1, Delete all references to NMX-J-325-ANCE
– 6.4.5: update reference to: NMX-J-578-ANCE-2006
– B3.8 (b): add NMX-J-591/1-ANCE-2007 & NMX-J-591/2-6-ANCE-2020
– C4.5.2: Add the reference NMX-J-295/2-ANCE-2010
– Correction: Add reference to UL 2054, in Section 2, Reference Publications
– Updates to E2 Reference Publications and E5 Markings and Instructions in Annex E for Special use lamps.

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as “CSA Group”), and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or ULSE at anytime. Revisions to this Standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and ULSE. CSA Group and ULSE will issue revisions to this Standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and ULSE pages.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Sixth Edition. The most recent designation of ANSI/UL 1993 as an American National Standard (ANSI) occurred on May 17, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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

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NOTE – The user’s attention is called to the possibility that compliance with this Standard may require use of an invention covered by patent rights. By publication of this Standard, no position is taken with respect to the validity of this claim or of any patent rights in connection there with. The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from ULSE.

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Preface

This is the harmonized ANCE, CSA Group, and ULSE standard for Self-Ballasted Lamps and Lamp Adapters. It is the fourth edition of NMX-J-578/1-ANCE, the fourth edition of CSA C22.2 No. 1993, and the sixth edition of UL 1993. This edition of NMX-J-578/1-ANCE supersedes the previous edition published in 2017. This edition of CSA C22.2 No. 1993 supersedes the previous edition published in 2017. This edition of UL 1993 supersedes the previous edition published in 2017.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and ULSE. 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 Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, 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. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified 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 ULSE 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.

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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, 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), Annex A, 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.

1.6 Self-ballasted lamps that emit electromagnetic energy (light) outside the 400 – 700 nm range shall additionally comply with Annex E.

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.

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*

ASTM B858-06, *Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys*

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*

ASTM D1000, *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 E28, *Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus*

C22.1-21, *Canadian Electrical Code, Part I, Safety Standard for Electrical Installations*

CSA-C22.2 No. 0:20, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.1:19, *General Requirements for Double-Insulated Equipment*

C22.2 No. 0.15-15 (R2020), *Adhesive labels*

CSA C22.2 No. 0.17:22, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 43-17(R2022), *Lampholders*

CSA C22.2 No. 66.1-06 (R2020), *Low Voltage Transformers – Part 1: General Requirements*

CSA C22.2 No. 74-16 (R2020), *Equipment for use with electric discharge lamps*

CSA C22.2 No. 248.14-00 (R2019), *Low Voltage Fuses – Part 14: Supplemental Fuses*

CSA C22.2 No. 250.0:21, *Luminaires*

CSA C22.2 No. 250.13:22, *Light Emitting Diode (LED) Equipment for Lighting Applications*

CSA C22.2 No. 256-14 (R2019), *Direct Plug-In Nightlights*

CSA C22.2 No. 60065:16 (R2020), *Audio, Video and Similar Electronic Apparatus – Safety Requirements*

CSA C22.2 No. 60950-1-07 (R2021), *Information Technology Equipment – Safety – Part 1: General Requirements*

CSA E60384-14:14 (R2018), *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC 60081, *Double-Capped Fluorescent Lamps – Performance Specifications*

IEEE C62.41, *IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits*

ISA MC96.1, *Temperature Measurement Thermocouples*

NEMA C82.3, *Electric Lamps – Reference Ballasts for Fluorescent Lamps*

NEMA C78.375A, *Electric Lamps – Fluorescent Lamps – Guide for Electrical Measures*

NEMA C78.40, *Electric Lamps – Specifications for Mercury Lamps*

NEMA C78.42, *Electric Lamps – High-Pressure Sodium Lamps*

NEMA C78.43, *Electric lamps: Single-Ended Metal Halide Lamps*

NEMA C78.81, *Electric Lamps – Double-Capped Fluorescent Lamps – Dimensional and Electrical Characteristics*

NEMA C78.389, *Electric Lamps – High Intensity Discharge Methods of Measuring Characteristics*

NEMA C78.901, *Electric Lamps – Single Base Fluorescent Lamps – Dimensional and Electrical Characteristics*

NEMA C82.5, *Lamp Ballasts – High-Intensity Discharge and Low-Pressure Sodium Lamps*

NFPA 70, *National Electrical Code (NEC)*

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*

NMX-J-024-ANCE-2018, *Iluminación – Portalámparas roscados tipo Edison – Especificaciones y métodos de prueba*

NMX-J-578-ANCE-2006, *Iluminación – Lámparas fluorescentes compactas autobalastradas – Seguridad y métodos de prueba*

NMX-J-198-ANCE-2015, *Iluminación – Controladores para lámparas fluorescentes – Métodos de prueba*

NMX-J-295/2-ANCE-2010, *Iluminación – Lámparas fluorescentes de doble base para alumbrado general – Especificaciones y métodos de prueba*

NMX-J-513-ANCE-2012, *Iluminación – Controladores de alta frecuencia para lámparas fluorescentes – Especificaciones*

NMX-565/2-11-ANCE-2005, *Prueba de riesgo de incendio – Parte 2-11: Métodos de prueba basados en hilo incandescente/caliente – Método de prueba de inflamabilidad de hilo incandescente para productos finales*

NMX-J-565/3-ANCE-2006, *Requisitos de seguridad – Inflamabilidad de materiales plásticos para partes en dispositivos y aparatos – Métodos de pruebas*

NMX-J-565/7-ANCE-2007, *Requisitos de seguridad – Resistencia a la ignición por arco de alta corriente – Método de prueba*

NMX-J-574-ANCE-2005, *Método para determinar los índices de prueba y de resistencia a la formación de caminos conductores en materiales aislantes sólidos*

NMX-J-591/1-ANCE-2007, *Dispositivos eléctricos de control automático para uso doméstico y similar Parte 1: Requisitos generales*

NMX-J-591/2-6-ANCE-2020, *Controles eléctricos automáticos – Parte 2-6: Requisitos particulares para controles de detección de presión eléctricos automáticos incluyendo requisitos mecánicos*

NOM-001-SEDE-2012, *Instalaciones Eléctricas (utilización)*

NOM-058-SCFI-2017, *Controladores para fuentes luminosas artificiales, con propósitos de iluminación en general-Especificaciones de seguridad y métodos de prueba*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 101, *Leakage Current for Utilization Equipment*

UL 248-14, Low-Voltage Fuses – Part 14: Supplemental Fuses

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, *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, *Tests for Flammability of Small Polymeric Component Materials*

UL 2054, *Household and Commercial Batteries*

UL 2097, *Reference Standard for Double Insulation Systems for Use in Electronic Equipment*

UL 8750, *Light Emitting Diode (LED) Equipment for Use In Lighting Products*

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 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-6, *Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements*

UL 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

2.2 Informative references

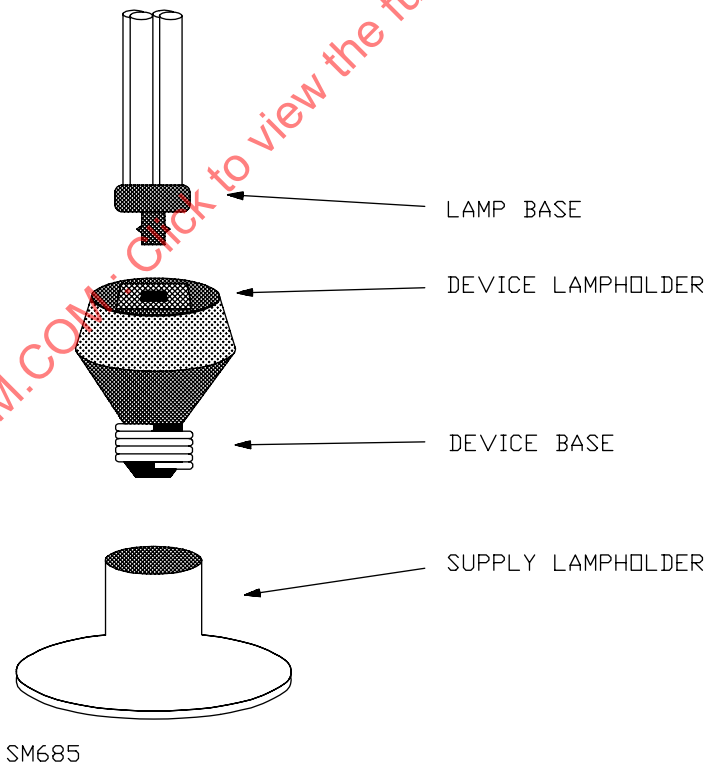
2.2.1 See Annex G for a list of component standards.

3 Definitions

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

Figure 3.1

Example of Terminology for Lamp Adapters



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 4.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Annex G 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 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 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_{rms}, 42.4 V_{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 mA_{rms} for perception and greater than 5.0 mA_{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 or CSA C22.2 No. 0 or NMX-J-198-ANCE-2015.

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 8.20 is considered not to be a fire-hazardous circuit.

4.5.2.4 Throughout this Standard, a suitable enclosure is described in 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 5.3.

5.1.3 A metal enclosure shall comply with the minimum thickness specified in Table 5.1. Alternatively, the suitability of the metal forming an Edison, G5 or G13 lamp base is determined by the applicable requirements and mechanical tests in UL 496 or CSA C22.2 No. 43 and 6.1.8.

Table 5.1
Thickness of Metal Enclosures

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:

a) Close-fitting to the emerging lead wires,

b) Free of burrs, sharp edges, and the like, that can abrade the insulation, and

c) Provided with a strain-relief means that complies with the strain relief test for lamp connectors of 8.12.

5.3 Polymeric materials

5.3.1 In Canada, a polymeric material shall comply with the requirements in CSA-C22.2 No. 0.17 and with the requirements of 5.3.2 to 5.3.4 and 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-2005 and to the following:

c) 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;

d) 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 5.3.2 to 5.3.6 when the material is used to:

e) Enclose electrical parts,

f) Provide direct or indirect support of live parts, or

g) 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 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 CSA-C22.2 No. 0.17 or NMX-J-565/3-ANCE-2006. Polymeric materials used solely to enclose electrical parts that are not part of a fire-hazardous circuit may have a minimum flammability rating of 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 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.

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

Test	Environmental rating	Minimum potential	PLC[e]
CTI[b]	Dry location	≥100 volts	4 or less
	Damp location	≥175 volts	3 or less
	Wet location	≥250 volts	2 or less
Test	**Flammability classification[a]**	**Minimum time**	**PLC[e]**
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[a]**	**Minimum time**	**PLC[e]**
HAI[d]	V-0, VTM-0	≥15 seconds	3 or less
	5-VA or 5-VB only	≥30 seconds	2 or less

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

[a] 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 CSA-C22.2 No. 0.17 or NMX-J-565/2-11-ANCE-2005. Subsequently, the HWI and HAI requirements are determined as a function of the flammability classification.

[b] Determined by prior classification or by the end-product tested in accordance with UL 746C or CSA-C22.2 No. 0.17 or NMX-J-574-ANCE-2005.

[c] Determined by prior classification or by the end-product tested in accordance with UL 746C or CSA-C22.2 No. 0.17 or NMX-565/2-11-ANCE-2005.

[d] Determined by prior classification or by the end-product tested in accordance with UL 746C or CSA-C22.2 No. 0.17 or by the high current arc resistance to ignition in accordance with NMX-J-565/7-ANCE-2007.

[e] 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

Device base	Maximum weight[a,c] kg (lbs)	Maximum moment[a,b] 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 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° 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° 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 or NMX-J-024-ANCE-2018, using the appropriate plug gauge specified in ANSI C81.63 for the intended lamp type.

5.5 Movable joints

5.5.1 Electrical conductors located in circuits considered a risk of fire or electric shock that are subject to movement shall be of the stranded type. The conductors shall be of sufficient length and suitably protected so that any movement does not stress electrical connections or cause conductors to bear against any sharp edges.

5.5.2 Any joint that allows movement while the lamp is installed in its lampholder(s) shall be constructed so that repeated adjustments do not have a detrimental effect on lamp components. Compliance shall be determined by the joint endurance test in 8.23.

5.5.3 Any rotational stops shall be sufficiently robust to withstand lamp insertion and repeated adjustments without damage. Compliance shall be determined by the joint torsion test in 8.2.3.

5.5.4 5.5.2 and 5.5.3 do not apply if:

a) The electrical circuits involved are not considered a risk of fire or electric shock; and

b) Any conductor damage or breakage would not reduce electrical spacings between normally isolated circuits.

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. See also 6.1.5. 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-2018.

6.1.2 A screwshell metal of a device base intended for damp or wet locations shall comply with Table 6.1:

Table 6.1
Acceptable Screw Metals vs. Lamp Environmental Rating

Metal composition	Dry locations	Damp locations	Wet locations
Copper alloy, any	Yes	No	No
Unplated Aluminum	Yes	Yes	No
Copper alloy, ≥ 80 % copper content	Yes	Yes	Yes
Copper alloy, compliant with the test in 8.21	Yes	Yes	Yes
Nickel alloy	Yes	Yes	Yes
Stainless Steel	Yes	Yes	Yes
Aluminum or copper alloy electroplated with nickel alloy covering all surfaces (after forming and trimming)	Yes	Yes	Yes

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 6.1.4. The lampholder keying shall comply with ANSI C81.61, ANSI C81.62, and ANSI 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 6.1.4. The lampholder keying shall comply with NMX-J-024-ANCE-2018.

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

6.1.5 In addition to the requirements referenced in 6.1.1, the flammability rating of polymeric materials used to form the lamp base body shall comply with 5.3.3 if the materials form part of the device's enclosure. This does not apply to contact insulators on Edison lamp bases.

6.1.6 The length of an Edison screw base, measured vertically from the plane of the eyelet contact (contact plate) to the plane of its furthest accessible conductive point as shown in Figure 6.1, shall not be greater than the maximum length indicated in Table 6.2.

Figure 6.1

Edison Screw Bases – Maximum Length

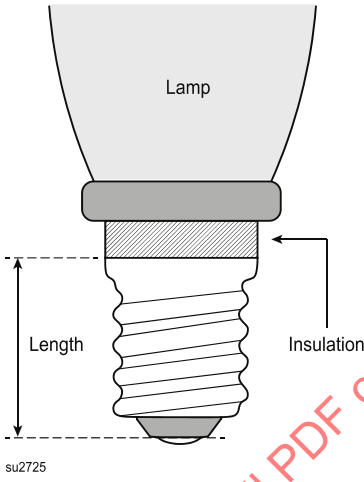


Table 6.2
Edison Screw Bases – Maximum Length

Designation	Max. length (mm)
E39 (Mogul)	42.9
E29 (Admedium)	30.2
E26 (Medium)	25.4
E17 (Intermediate)	21.4
E12 (Candelabra)	17.5
E11 (Mini-candelabra)	15.9

6.1.7 Any insulation used to prevent contact with part of the screw base shall be secured to minimize the likelihood of displacement due to incidental contact by users. The suitability of the securement means shall be determined by performing the Base Insulation Displacement test in 8.11 prior to making the measurements specified in 6.1.6.

6.1.8 G5 and G13 lamp bases functioning as fire or electrical enclosures and formed from metal thinner than specified in Table 5.1 shall comply with either of the Pin Strength tests described in ANSI C81.61 standard sheets 1-310 or 1-406, respectively.

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. Soldered joints that comply with 8.22 are considered to 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 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 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 mm^2 (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 8.12.

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 6.4.1).

In Mexico, 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 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 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 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 CSA-C22.2 No. 60065 or the requirements of NMX-J-578-ANCE-2006. 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, 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 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 8.5.

In Mexico, 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 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 6.6.5 to 6.6.7.

6.6.3 A spacing described in 6.6.1 shall not be less than the values specified in Table 6.3.

Table 6.3
Minimum Spacing, Dry, Damp, and Wet Locations

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 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 9.6 is inserted through any opening without contacting any hazardous live parts.

6.7.2 The articulated probe of 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 8.17 shall be conducted.

c) For lamp adapters that employ an electronic ballast, one of the end-of-lamp-life tests as described in 8.18 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 8.19 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 6.10.1 or 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 Figure L.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 6.6,

b) Have base contacts made of materials suitable for use in damp locations that comply with the requirements in 6.1.2, and

c) Comply with the humidity test of 8.14 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 6.6,

b) Have base contacts made of materials suitable for use in wet locations that comply with the requirements in 6.1.2,

c) Have polymeric enclosures comply with the UV rating of 5.3,

d) Comply with the humidity test of 8.14 if the device has accessible non-current-carrying metal parts,

e) Comply with the water spray test of 8.15, and

f) Comply with the cold impact test of 8.16.

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 Section 9.

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

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

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 the 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 the 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 the same as used in drop test.

Table 8.1 Continued on Next Page

Table 8.1 Continued

Test description	Reference	Number and description of samples
Deflection test	8.10	1 sample of each enclosure type; may be the same as used in drop test.
Strain relief test	8.12	If device has lead wires and is not potted, 1 sample; can be the same as used above.
Joint endurance test	8.23	For lamps with movable joints; one sample.
Joint torsion test	8.24	For lamps with movable joints and a rotational stop; one sample.
Special Tests		
Tests with dimmer circuits	8.13	1 sample; may be used in previous tests.
Humidity conditioning test	8.14	For damp location rating, 1 sample; may be used in previous tests.
Water spray test	8.15	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	8.16	For wet location rating, three samples of each enclosure type.
Lamp fault conditions tests	8.17	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	8.18	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	8.19	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.
Moist ammonia air stress cracking test	8.21	For damp or wet location devices with copper-alloy screw bases with less than 80 % copper content. Three samples shall be tested.
Miscellaneous		
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 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 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 6.1.3.

8.2 Input measurements

8.2.1 With the ballast energized at the input voltage and frequency in accordance with 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 8.13.2.1 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:

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

in which the *input wattage*, *voltage*, and *current* are measured in accordance with 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 8.1.5 and 8.1.6, and with device lampholders not keyed in accordance with ANSI C81.61, ANSI C81.62, and ANSI 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 8.5.2 to 8.5.16.

8.5.2 The maximum temperatures shall not exceed those specified in Table 8.2 when corrected to a room ambient temperature. Ambient temperature variations above or below the room ambient temperature shall be respectively subtracted from or added to temperatures recorded at points on the device. The room ambient temperature shall be either 25 ±5 °C, or the elevated ambient temperature used in 8.5.17 – 8.5.18.

Table 8.2
Maximum Acceptable Temperature Limits

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	
	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 E28;

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 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 protective device or function shall not operate during this test to reduce the current or power to the device, as determined by the measurements in 8.5.5, except as noted in 8.5.4.

8.5.4 Electronic circuits that operate during this test to reduce the current or power to the device shall comply with the Safety-related electronic circuit (SREC) requirements in UL 8750.

8.5.5 The device input supply electrical parameters (V, A, W) shall be recorded 15 minutes after the start of the test and again at the end of the test. The input current and power measurements shall comply with 8.2. The current and power measurements recorded at the end of the test shall be within 10 percent of the initially recorded values.

8.5.6 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 25 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 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 9.5.3 and depicted in Figure 9.2, or

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.

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

8.5.8 A device that is not marked in accordance with Table 10.1, Item 13, shall comply with the dimmer tests of 8.13.

8.5.9 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.

8.5.10 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.

8.5.11 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.

8.5.12 Thermocouples shall comply with 9.3.

8.5.13 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.

8.5.14 The temperature of a winding shall be measured by a thermocouple or by the rise of resistance method in accordance with 8.5.15.

8.5.15 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 °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 °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. °C, and

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

8.5.16 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.

8.5.17 A lamp may be optionally tested in an elevated room ambient above 25 °C, in 5 °C increments. The lamp shall be mounted in the appropriate test fixture and shall be:

a) Tested using a source of heated air providing the elevated temperature for which the lamp will be marked. The maximum airflow past the lamp or test fixture shall be less than 9.1 m/min (30 ft/min). Maximum variations of 5 °C from the intended ambient temperature shall be added to or subtracted from the observed temperature readings; or

b) Tested at an ambient temperature of 25 ±5 °C, and the full difference between the actual test ambient temperature and the intended elevated ambient temperature shall be added to the observed temperature readings.

8.5.18 Lamps tested per 8.5.17 that comply with the limits in Table 8.2 are permitted to be marked in accordance with Table 10.1, Item 31.

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.

8.6.4 The sensitivity of the test equipment shall be such that when a 120,000 ohms minimum calibrating resistor is connected across the output, the equipment indicates acceptable performance for any output voltage less than the specified test voltage, and indicates unacceptable performance for any output voltage equal to or greater than the specified test voltage.

8.7 Harmonic distortion test

8.7.1 A device rated for a harmonic factor (HF) or total harmonic distortion (THD) of the supply current shall be tested as described in 8.7.2 and 8.7.3. With the device base up and energized at the input voltage and frequency in accordance with 8.1.5 and 8.1.6, HF or THD shall not be more than the manufacturer's specified rating made for the device by 10 percent when controlling a lamp or lamps that the device lampholder is intended to accommodate.

8.7.2 The supply for the test shall be generated by an electronic power supply having a voltage distortion of less than 0.5 percent. Since the source (supply) voltage will affect the magnitude of the harmonics, for measuring purposes, the supply impedance shall be 0.08 ohm. For some electronic supplies it will be necessary to add resistance to obtain the specified supply impedance.

8.7.3 The magnitude of the various harmonics of the supply frequency shall be recorded to the thirty-third (33) harmonic. The harmonic factor is the ratio of the harmonic content to the rms value of the fundamental. The harmonic factor (*HF*) shall be calculated as follows:

$$HF = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots}}{I_1}$$

The total harmonic distortion (*THD*) shall be calculated as follows:

$$THD = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots}}{\sqrt{I_1^2 + I_2^2 + I_3^2 + I_4^2 + \ldots}}$$

in which:

I_1 = 100 percent at the fundamental frequency,

I_2 = magnitude, in percent of the fundamental, of the second harmonic, and

I_3 = magnitude, in percent of the fundamental, of the third harmonic.

8.8 Drop impact test

8.8.1 A device with a polymeric enclosure shall be subjected to the tests described in 8.8.2 and 8.8.3. There shall be no damage to the enclosure making uninsulated live parts or internal wiring accessible to contact or defeating the mechanical protection of internal parts of the equipment afforded by the enclosure. For adapters, the test is conducted since it is assumed the user would replace the lamp. For self-ballasted lamps the test is done because the lamp could be damaged, but it would not be obvious, for example if the lamp is enclosed.

8.8.2 A device shall be subjected to the impact test as follows:

a) A device shall be dropped 0.91 m (3 ft) striking a hardwood surface in the position most likely to produce adverse results. The hardwood surface shall consist of a layer of nominal 25 mm (1 in) thick tongue-and-groove oak flooring mounted on two layers of nominal 19 mm (3/4 in) thick plywood. The assembly shall rest on a concrete floor or an equivalent non-resilient floor during the test.

b) A device shall be dropped three times so that, in each drop, the sample strikes the surface in a position different from those in the other two drops.

8.8.3 A device having accessible non-current-carrying metal parts that could be energized from within shall subsequently be subjected to the dielectric voltage-withstand test of 8.6. There shall be no breakdown as a result of the dielectric voltage-withstand test. There shall be no damage to the enclosure making uninsulated live parts or internal wiring accessible to contact, which is determined using the articulated probe described in Figure 9.3, or defeating the mechanical protection of internal parts of the equipment afforded by the enclosure.

8.8.4 Accessibility criteria are not applied to broken discharge tubes.

8.9 Mold-stress relief conditioning

8.9.1 A completely assembled device having a polymeric enclosure shall be placed in a circulating air oven and maintained at a temperature 10 °C higher than the maximum temperature taken during the normal temperature test of 8.5 when tested in a recessed luminaire, or not less than 70 °C for a period of 7 hours.

8.9.2 For a family or grouping of enclosures, such as different sizes for a range of lamp wattages, representative samples of the largest and the smallest enclosures shall be tested. For additional polymeric materials, representative samples of the largest and the smallest enclosures made of each generic type of material (ABS, PBT, PC, PBT/PVC blends, etc) shall be tested. Enclosures made of additional polymeric materials of the same generic type need not be tested (see Appendix A of UL 746C for a discussion of alternate material considerations).

8.9.3 After conditioning, there shall be no softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion as judged after cooling to room temperature, that results in any of the following:

a) Reduction of clearance (through air spacing) between uninsulated live parts of opposite polarity, or, uninsulated live parts and accessible non-current-carrying metal.

b) Making uninsulated live parts or internal wiring accessible to contact, using the probe in Figure 9.3.

8.10 Deflection test

8.10.1 The enclosure of a device shall be capable of withstanding a force of 89 N (20.0 lbf) applied using a 12 mm (0.472 in) diameter rod with a hemispherical end.

8.10.2 This test is applicable only for devices having enclosures consisting of two molded pieces that snap together.

8.10.3 The force shall be gradually increased from zero until the specified value is reached and then maintained for a period of one minute. The force, when applied along a joint of snap-together parts or to any part of the enclosure, shall not result in a shock hazard or damage that can create a fire hazard.

8.11 Base insulation displacement test

8.11.1 If adhesive is used to secure the insulation, then prior to this test, the lamp shall be subjected to the pre-conditioning cycle of the adhesive support test in A5.3.5.

8.11.2 Using a 12 mm (0.472 in) diameter rod with a hemispherical end, a force of 4.45 N (1 lbf) ±10 % shall be applied against the insulation for 5 seconds, in the manner likely to cause the most adverse displacement. Any conductive surface exposed by this force shall be considered accessible for the purposes of 6.1.6, including those that are only exposed momentarily during the application of the force.

8.12 Strain relief test for lamp connectors

8.12.1 The lamp lead wires that exit the enclosure of a circular fluorescent device shall be subjected to a perpendicular force of 22 N (5 lbs) applied to each lead wire for 1 min.

8.12.2 The lamp leads exiting from the enclosure shall have no movement of any lead greater than 1.6 mm (1/16 in) after the force of 8.12.1 is applied.

8.13 Tests of dimmer circuits

8.13.1 General

8.13.1.1 A device that is intended to operate on a standard dimmer, shall be subjected to the normal operation test specified in 8.13.2.

8.13.1.2 A device that is not intended to be dimmable, shall be subjected to the abnormal temperature test of 8.13.3. These devices shall be marked in accordance with Table 10.1, item 13.

8.13.1.3 A dimmable device that is not intended to operate on a standard dimmer (e.g.: wireless control) shall be subjected to the abnormal temperature test of 8.13.3 with its integral dimming control set for full brightness. These devices shall be marked in accordance with Table 10.1, Item 14 and provided with the instructions specified in 10.4.5.

8.13.2 Normal operation test

8.13.2.1 Devices described in 8.13.1.1 shall comply with the temperature test of 8.5 when operated with power supply sources of 8.13.4 and 8.13.5.

8.13.3 Abnormal test

8.13.3.1 Devices described in 8.13.1.2 or 8.13.1.3 shall be energized with the sources of supply specified in 8.13.4 and 8.13.5, in a room ambient of 25 °C in the base down position. During the test, the device excluding the light source shall be draped with cheesecloth that complies with 9.8. The cheesecloth shall be loosely draped over the device in order to indicate as a flame indicator (presence of ash or burnt holes) but shall not to be used as a blanket to trap heat.

8.13.3.2 When operated as specified in 8.13.3.1 for 7-1/2 hours, there shall be:

a) No flaming, glowing, or charring of the cheesecloth, or

b) No damage to the enclosure which would allow the articulated probe of 9.6 to touch live parts and the device shall be capable of complying with the dielectric voltage-withstand test of 8.6.

8.13.4 Half-wave rectified supply

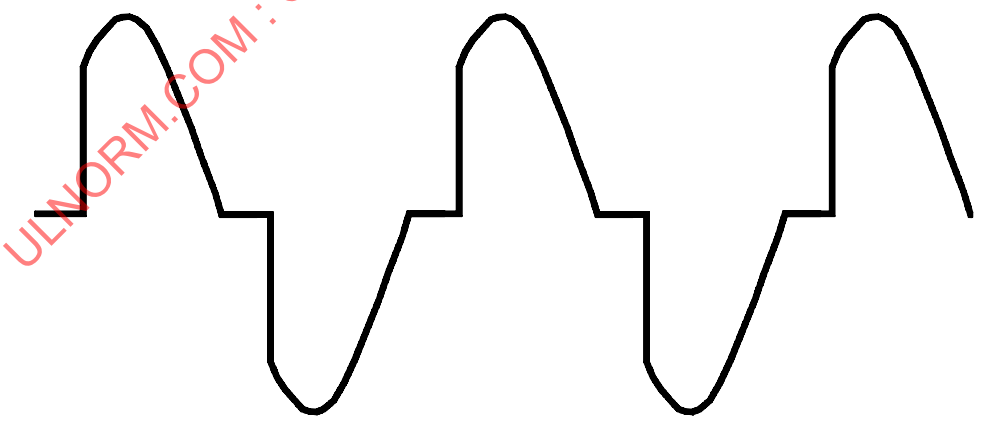
8.13.4.1 A source of supply as specified in 8.1.5 and 8.1.6 shall be operated with a single, appropriately rated semiconductor diode in series with the ungrounded conductor of the supply.

8.13.5 Adjustable dimmer supply

8.13.5.1 A source of supply as specified in 8.1.5 shall be operated with an adjustable dimmer electrically wired in series. The dimmer shall be an adjustable phase-cut type that does not contain any components in its output circuitry for waveform smoothing and should produce an output waveform with a variable conduction angle similar to that depicted in Figure 8.1. The dimmer shall be adjusted to cause the maximum heating of the device.

Figure 8.1

Phase-Cut Type Dimmer Output Waveform



8.14 Humidity conditioning

8.14.1 A device intended for use in damp or wet locations (see 7.2 and 7.3) shall be exposed for 48 hours to moist air having a relative humidity of 93 ±5 % at a temperature of 25 ±2 °C. Following the 48-hour period and while still exposed to moist air, the device shall comply with the requirements for dielectric voltage-withstand between current-carrying parts and accessible non-current-carrying metal parts in

accordance with 8.6 and operate normally. Alternate chamber conditions may be 88 ±5 % at a temperature of 32 ±2 °C or 93 ±5 % at a temperature of 28 ±2 °C.

8.15 Water spray test

8.15.1 A device intended for use in wet locations (see 7.3) shall be subjected to the test described in 8.15.2. Water shall not enter the ballast or device lampholder compartments. A device that is marked to indicate a specific orientation or restricted positioning (refer to Table 10.1, Item 12, for marking) shall be positioned as marked. A device without a marking for a specific orientation or restricted positioning shall be positioned in the way that results in the most severe test results. A device constructed so that it is sealed to exclude water can be marked per Table 10.1, Item 11, and need not be subjected to this test.

8.15.2 A device shall be tested by applying a water spray as described in 9.7 for 1 hour.

8.16 Cold impact test

8.16.1 A device with a polymeric enclosure and marked for use in wet locations shall comply with the cold impact test (minus 35 °C) as described in 8.16.2.

8.16.2 Three samples shall be cooled to a temperature of minus 35 ±2 °C and maintained at this temperature for 3 hours. While the unit is cold, the specimens shall be subject to the drop test described in drop test in 8.8.

8.17 Lamp fault conditions test

8.17.1 A self-ballasted lamp or adapter that employs an electronic ballast shall accept the following fault conditions specified, introduced one at a time, without increasing the risk of fire or shock:

a) A lamp with one cathode open-circuited,

b) A broken lamp, i.e., a lamp with both cathodes intact, but that will not start, and

c) A lamp that operates with one cathode open-circuited, i.e., rectifying effect.

8.17.2 The fault conditions specified in 8.17.1 shall be simulated as follows:

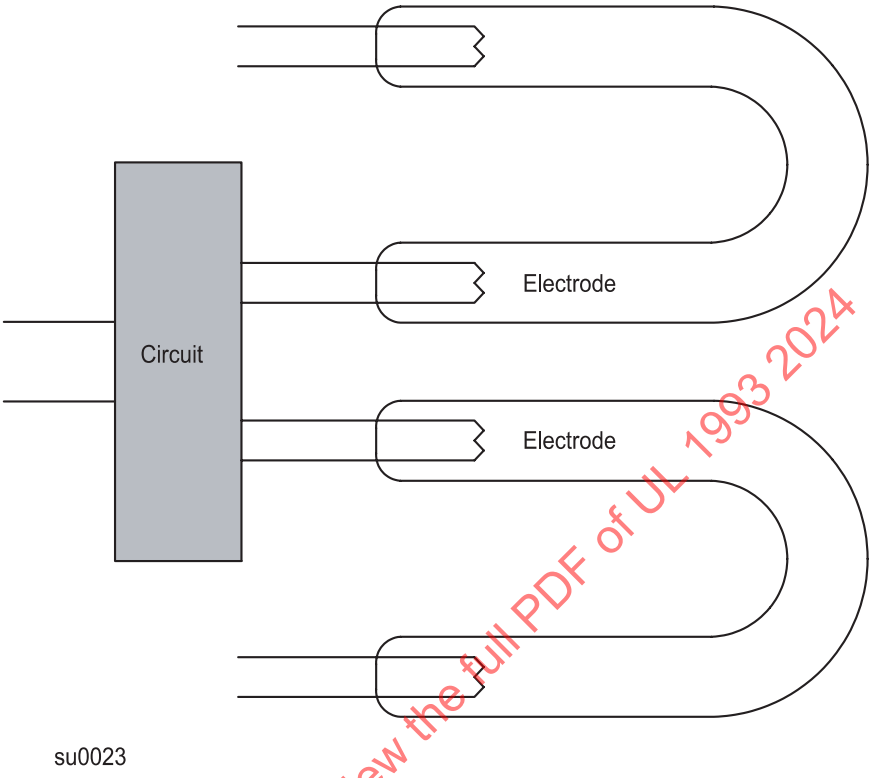
a) Disconnect one side of one cathode and then start the lamp. Repeat test for each cathode lead using a different lamp, if necessary.

b) Connect two separate wire lamps to the cathode circuit and then start the lamp. See Figure 8.2.

c) Start the lamp, wait five minutes, and then disconnect one side of a cathode. Repeat for each cathode lead wire using a different lamp, if necessary.

Figure 8.2

Fault Conditions Test Diagram



8.17.3 A self-ballasted lamp or adapter shall be placed on a knot-free pine board covered with a double layer of cheesecloth. A double layer of cheesecloth shall be draped over the unit.

8.17.4 The self-ballasted lamp or adapter shall be energized from a power supply of rated voltage and frequency. The unit shall operate under each fault condition until it fails to operate or for at least 1 hour after the fault is introduced. If at the end of one hour the unit exhibits abnormal behavior, then continue the test up to five hours. After each fault condition and before the cheesecloth is removed, the cheesecloth shall be inspected for evidence of ignition, burning, or strand separation.

8.17.5 The results of the test comply with this Standard if:

a) The cheesecloth does not ignite or burn, nor shall the strands of the cheesecloth reach the point of separation.

b) There are no openings created in the enclosure that permit the accessibility probe described in Figure 9.3 to contact any part that is operating at risk of shock levels.

c) The sample complies with a dielectric voltage-withstand test between line and accessible metal parts.

8.18 End-of-lamp-life tests for fluorescent lamp adapters

8.18.1 General

8.18.1.1 Any one of the following three tests may be used to qualify a lamp adapter:

a) Asymmetric pulse test (described in 8.18.2),

b) Asymmetric power dissipation test (described in 8.18.3), and

c) Open filament test (described in 8.18.4).

The results of each test are considered to be in compliance when the wattage or current is less than the limit specified in the individual test.

8.18.1.2 The manufacturer shall declare which one of the three tests will be used to test a given adapter, based on the design of that particular adapter circuit.

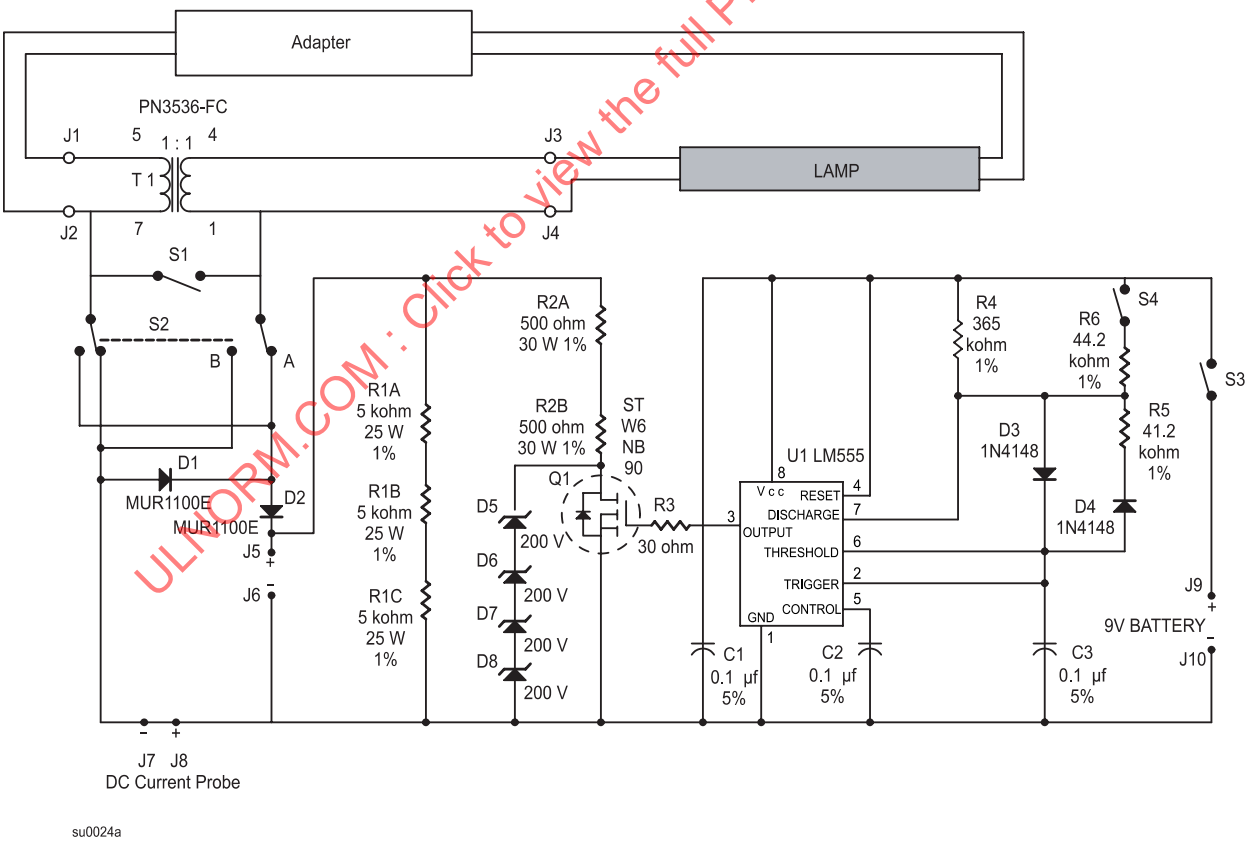
8.18.1.3 Lamps used in the adapter test circuits shall be new lamps seasoned for 100 h.

8.18.2 Asymmetric pulse test

8.18.2.1 Refer to the schematic diagram in Figure 8.3.

Figure 8.3

Asymmetric Pulse Test Schematic



Note – FET Q1 should be on for 3 ms and off for 3 ms when S4 is closed, and on for 27 ms and off for 3 ms when S4 is open.

8.18.2.2 The following values of maximum cathode power P_{max} apply:

a) For lamps with diameters 13 mm or smaller, P_{max} = 5.0 W, and

b) For lamps with diameters greater than 13 mm, P_{max} = 7.5 W

8.18.2.3 If only one connection per electrode is available at the ballast and/or lamp, T1 shall be removed, and then the ballast shall be connected to J2 and the lamp to J4. The ballast manufacturer should be asked which of the output terminals has to be connected to J4 and, in case two output terminals per electrode exist, whether they can be short-circuited or be bridged with a resistor. Conduct the test as follows:

a) Close switches S1 and S4, and set switch S2 to position A.

b) Turn on the ballast under test and allow lamp or lamps to warm up for 5 minutes.

c) Close S3, open S1, and wait for 15 seconds. Open S4 and wait for 15 seconds.

d) Measure the sum of the average power dissipated in the power resistors, R1A to R1C and R2A and R2B, and the Zener diodes D5 to D8.

Note: The power should be measured at the average value of the product of the voltage between terminals J5 and J6 times the current flowing from J8 to J7. The voltage should be measured with a differential voltage probe, and the current should be measured with a DC current probe. A digital oscilloscope can be used for the multiplication and averaging functions. If the ballast operates in a cycling mode, the averaging interval should be set to cover an integer number of cycles.(Each cycle is typically greater than 1 second.) The sampling rate and number of samples included in the calculations should be sufficient to avoid aliasing errors.

The power dissipation shall be below P_{max}. If the power dissipation is greater than P_{max}, the ballast has failed and the test is discontinued.

e) Close S1 and S4.

f) Set S2 to position B.

g) Repeat steps (b), (c), and (d) above. The ballast shall pass both position “A” and position “B” tests.

h) For multi-lamp ballasts, repeat steps a through g for each lamp position. A multi-lamp ballast shall pass the tests for each lamp position.

i) For ballasts that operate multiple lamp types (e.g., 26W, 32W, 42W, etc.) each lamp type specified shall be tested. Repeat steps (a) through (h) for each lamp type.

8.18.2.4 The following components are used in the asymmetric pulse test circuit:

U1 – 555 timer IC

T1 – 1:1 transformer (see 8.18.2.5)

D1, D2 – ultra-fast recovery diode, 1000 V, 1 A, 75 ns

D3, D4 – signal diode, 75 V, 200 mA

D5 to D8 – Zener diode, 200 V

Q1 – Mosfet 900 V, 6 A

R1A to R1C – resistor, 5 kΩ, 25 W, 1 %

R2A and R2B – resistor, 500 Ω, 30 W, 1 %

S1, S3, and S4 – switch

S2 – switch, double

Battery – battery, 9 V

C1, C2, C3 – capacitor, 0.1 µF, 50 V, 5 %

R3 – resistor, 30 Ω, 1/4 W, 5 %

R4 – resistor, 365 kΩ, 1/4 W, 1 %

R5 – resistor, 41.2 kΩ, 1/4 W, 1 %

R6 – resistor, 44.2 kΩ, 1/4 W, 1 %

8.18.2.5 The specification for the transformer (T1) listed in 8.18.2.4 as follows:

Core – two EI187 (E19/8/5), core area 22.6 mm^2, P material or equivalent

Bobbin – 8-pin, horizontal mount

Primary winding – 38 turns, 26 AWG HN, 19 turns/layer, start pin 5, finish pin 7

Inter-winding insulation – 5 layers 3M #56 3/8 in. or equivalent

Secondary winding – 38 turns, 26 AWG HN, 19 turns/layer, start pin 4, finish pin 1

Wrapper – 2 layers 3M #56 3/8 in. or equivalent

Inter-winding capacitance – Approximately 22 pF

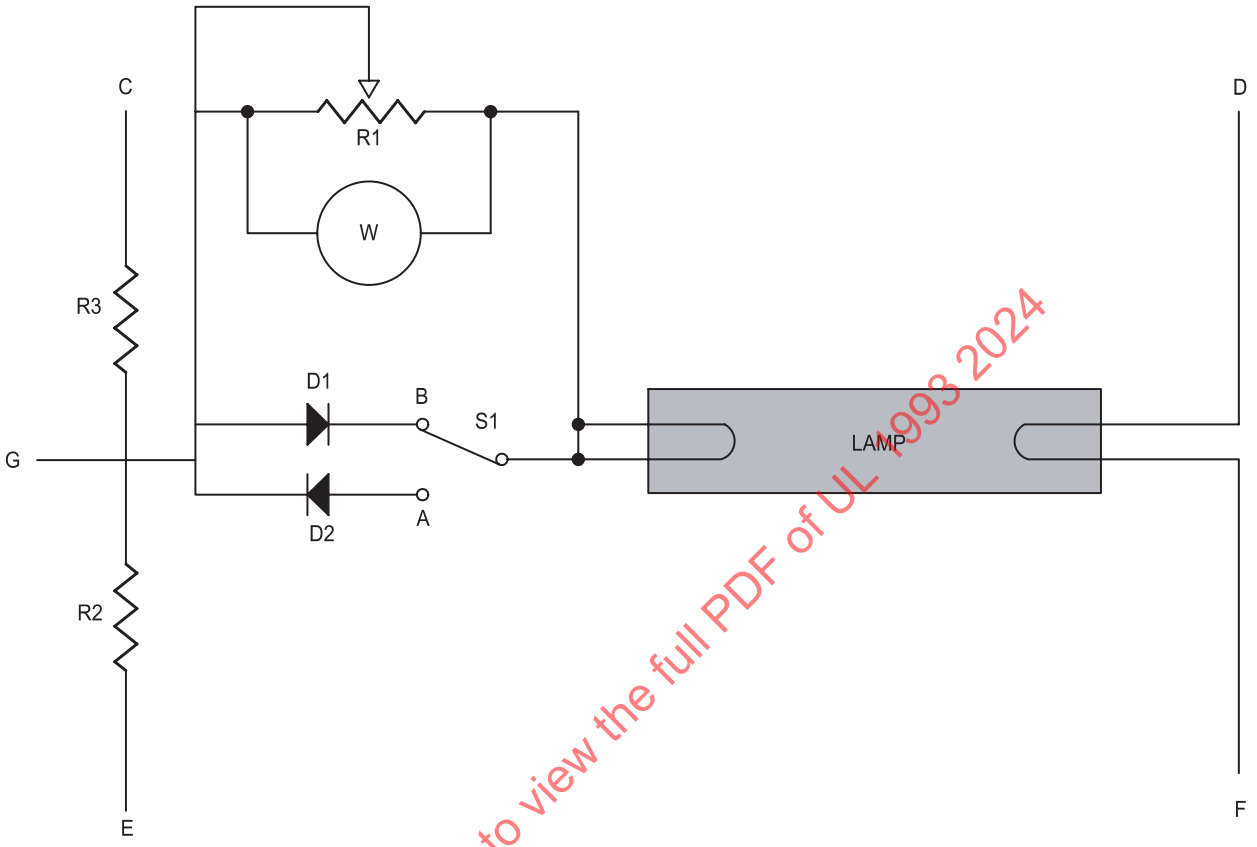
HIPOT – 2500 V_{rms}

8.18.3 Asymmetric power test

8.18.3.1 Refer to the schematic diagram in Figure 8.4.

Figure 8.4

Asymmetric Power Test Schematic



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Note 1 – R2 = R3 = Ω (this resistance is 1/2 resistance of hot cathode – refer to lamp data sheet)

Note 2 – C, D, E, and F represent cathode connections for the ballast

Note 3 – For instant start ballasts, connection G is connected to one terminal and the combined D and F are connected to the other terminal.

8.18.3.2 The test sequence shall be as follows:

a) Set switch S1 to position A.

b) Set resistance of resistor R1 to 0 (zero) Ω.

c) Start lamp or lamps by turning on power to ballast under test and allow lamp or lamps to warm up for 5 minutes.

d) Increase the resistance of R1 rapidly (within 15 seconds) until the power dissipated by resistor R1 equals the test wattage value of 10 W for lamps with diameters 13 mm or smaller, or 15 W for larger lamps. If the ballast limits the power in R1 to a value less than the test wattage, set R1 at the value that produces the maximum wattage. If the ballast switches off before reaching the test wattage, continue with (e). If the ballast does not switch off and limits the power in R1 to a value less than the test wattage, set R1 at the value that produces the maximum wattage.

e) If the test wattage value was reached in step (d), wait for an additional 30 seconds. Measure the power in R1. The power dissipation in resistor R1 shall be below or equal to P_{max}. If the power dissipation in resistor R1 is greater than P_{max}, the ballast has failed and the test is discontinued.

f) Turn off power to ballast. Set switch S1 to position B.

g) Repeat test procedure steps (c) to (e) above. The ballast shall pass both position “A” and position “B” tests.

h) For multi-lamp ballasts, repeat test procedure, steps a through g for each lamp position. A multi-lamp ballast shall pass the tests for each lamp position.

i) For ballasts that operate multiple lamp types (e.g., 26W, 32W, 42W), each lamp type specified shall be tested. Repeat steps (a) to (h) for each lamp type.

8.18.3.3 The following components are used in the asymmetric power test:

R1 – adjustable resistor, 1 kΩ, 100 W in series with 5 kΩ, 100 W

R2, R3 – resistor, (value specified by manufacturer of the lamp under test), 5 W, 5 %

D1, D2 – high voltage diodes, RGB30M

S1 – switch

8.18.4 Open filament test

8.18.4.1 Test selection

8.18.4.1.1 The adapter shall have adequate protection to prevent lamp base overheating at the end of the lamp life cycle under open filament conditions. Compliance is checked by either test procedure A or B as determined by the value of I_{max} below.

8.18.4.1.2 During the test the following values of maximum lamp current I_{max} apply:

a) For lamps with outside tube diameter of 13 mm or smaller, I_{max} = 1 mA, and

b) For lamps with outside tube diameter greater than 13 mm, I_{max} = 1.5 mA.

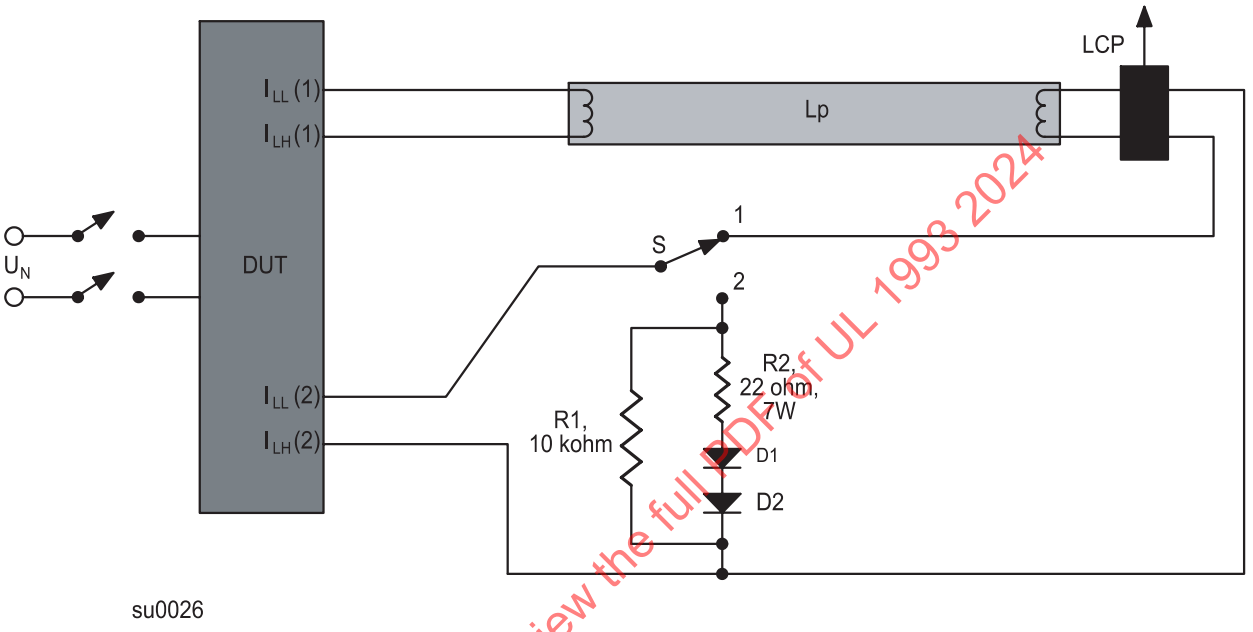
8.18.4.1.3 If these current values are exceeded, test procedure B shall be applied; otherwise test procedure A shall be applied.

8.18.4.2 Measurements to be carried out prior to test procedure A

8.18.4.2.1 Connect the circuit according to Figure 8.5.

Figure 8.5

Open Filament Test Circuit: Electrode (1) Check



8.18.4.2.2 Determine the rms currents $I_{LL}(1)$, $I_{LH}(1)$, $I_{LL}(2)$, and $I_{LH}(2)$ at the adapter output terminals, by using a current probe, and mark the terminals respectively, where:

a) $I_{LL}(1)$ is the lower of the rms currents through lead-in wire of electrode 1,

b) $I_{LH}(1)$ is the higher of the rms currents through lead-in wire of electrode 1,

c) $I_{LL}(2)$ is the lower of the rms currents through lead-in wire of electrode 2, and

d) $I_{LH}(2)$ is the higher of the rms currents through lead-in wire of electrode 2.

8.18.4.3 Test procedure A

8.18.4.3.1 The test sequence shall be as follows:

a) Set S to position 1.

b) Turn on the adapter under test and allow lamp or lamps to warm up for 5 min.

c) Set S to position 2 and wait for 30 s.

d) Measure the rms current value of $I_{lamp} = I_{LH} - I_{LL}$ with the current probe near to the lamp end. If I_{lamp} is pulsing, the rms shall be computed over one complete pulse cycle including time off.

The lamp discharge current I_{lamp} shall not be greater than I_{max}.

If the lamp discharge current is greater than I_{max}, the adapter has failed, and the test is discontinued.

e) Connect the lamp to the adapter as shown in Figure 8.6. The following components are used in the open filament test circuit for test procedure A, electrode (2) check:

R1 – resistor, 10kΩ, 7 W

R2 – resistor, 22 Ω, 7 W

D1 and D2 – high voltage diodes, RGB30M

S – switch

Lp – lamp

LCP – lamp current probe

U_N – supply

DUT – device under test

f) Set S to position 1.

g) Turn on the adapter under test and allow lamp or lamps to warm up for 5 min.

h) Set S to position 2 and wait 30 s.

i) Measure rms current value of I_{lamp} with the current probe near to the lamp end. If I_{lamp} is pulsing, the rms value shall be computed over one complete pulse cycle including the off time.

The lamp discharge current I_{lamp} shall not be greater than I_{max}.

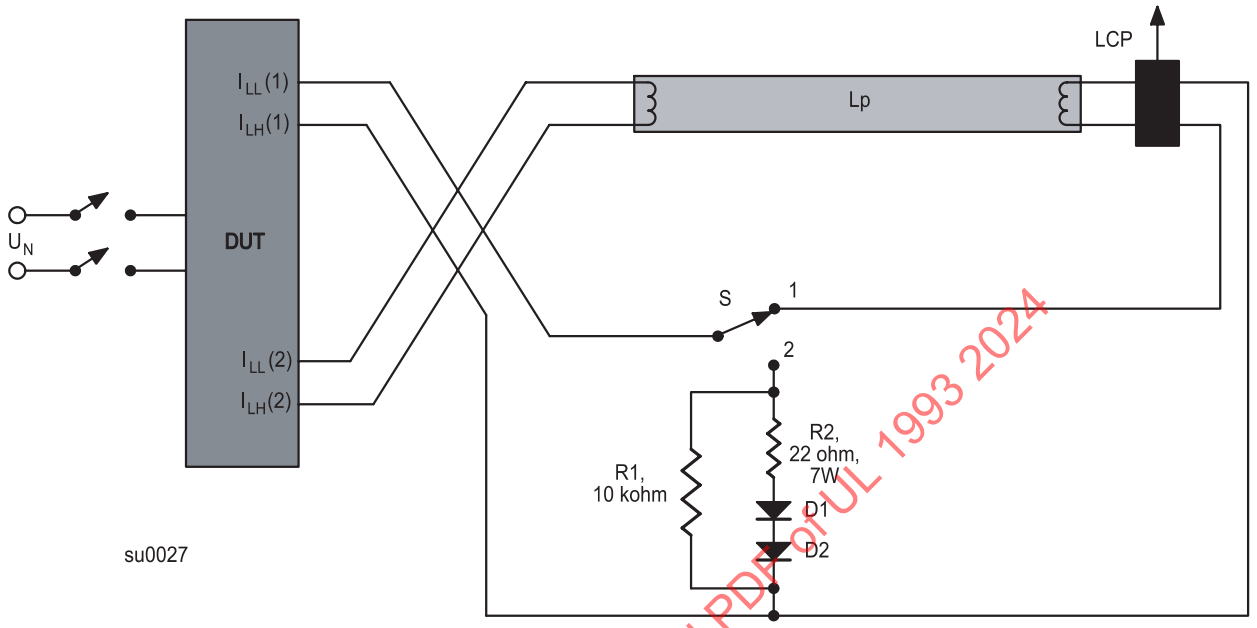
j) For multi-lamp adapters, repeat test procedure steps (a) through (i) for each lamp position.

A multi-lamp device shall pass the tests for each lamp position.

k) For adapters that operate multiple lamp types (e.g. 26 W, 32 W, 42 W), each lamp type specified shall be tested. Repeat steps (a) through (j) for each lamp type.

Figure 8.6

Open Filament Test Circuit: Electrode (2) Check



8.18.4.3.2 The following components are used in the open filament test circuit for test procedure A, electrode (1) check (see Figure 8.5):

R1 – resistor, 10kΩ, 7 W

R2 – resistor, 22 Ω, 7 W

D1 and D2 – high voltage diodes, RGB30M

S – switch

Lp – lamp

LCP – lamp current probe

U_N – supply

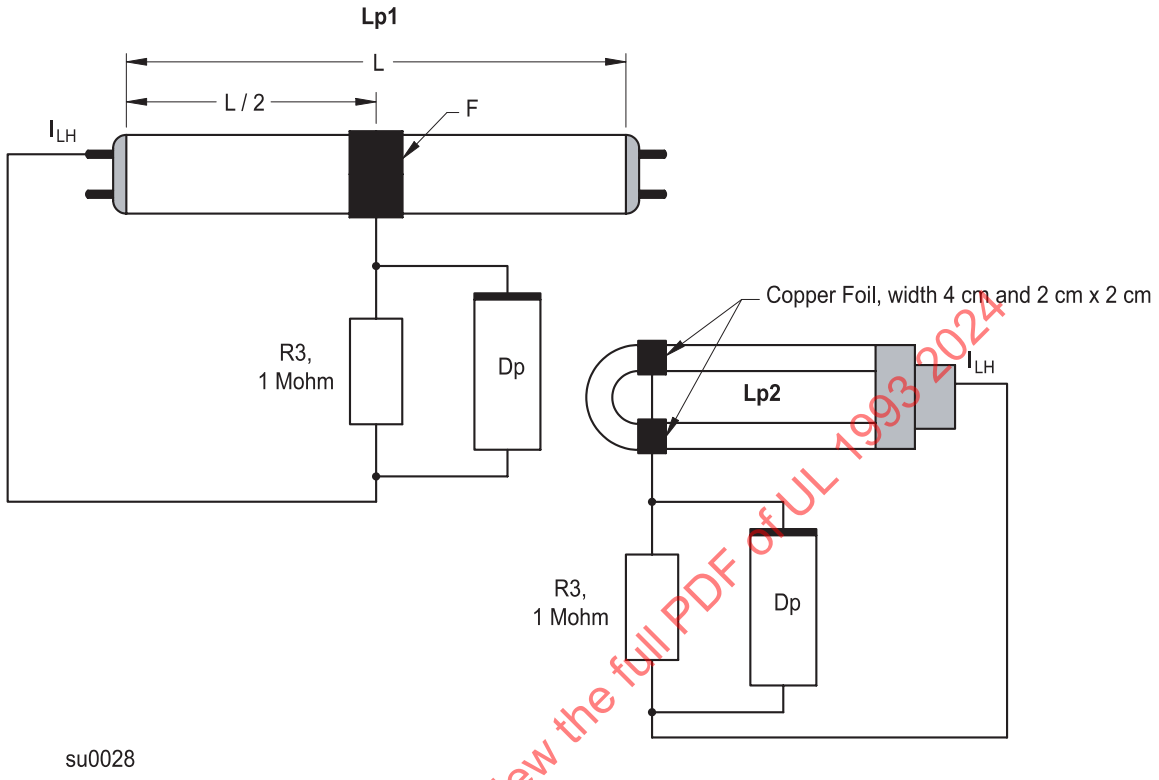
DUT – device under test

8.18.4.4 Test procedure B

8.18.4.4.1 Connect the lamp as shown in Figure 8.5 and Figure 8.6 with the measurement arrangement according to Figure 8.7. If the adapter has an isolation transformer, connect the 1 MΩ resistor to the corresponding terminal as defined in 8.18.4.3.

Figure 8.7

Detection of Lamp Current



8.18.4.4.2 The test sequence shall be as follows:

a) Set S to position 1.

b) Turn on the ballast under test and allow lamp or lamps to warm up for 5 min.

c) Set S to position 2 and wait for 30 s.

d) Measure the rms voltage value with the differential probe placed as indicated in Figure 8.7. If the voltage is pulsing, the rms value shall be computed over one complete pulse cycle including the off time.

e) The voltage shall not be greater than 25 percent of the rated lamp voltage from the applicable ANSI or IEC lamp standard. If the lamp is not standardized, then the lamp voltage shall be declared by the manufacturer. If the voltage is greater than 25 percent, discontinue the test. Refer to Figure 8.6.

f) Repeat the test procedure steps (a) through (d) above.

g) For multi-lamp devices, repeat test procedure steps (a) through (e) for each lamp position.

A multi-lamp device shall pass the test for each lamp position in order to pass the end-of-life lamp test.

h) For adapters that operate multiple lamp types (e.g. 26 W, 32 W, 42 W), each lamp type specified shall be tested.

Repeat steps (a) through (f) for each lamp type. A multiple lamp adapter shall pass the test for each lamp type.

8.18.4.4.3 The following components are used in the open filament test circuit for test procedure B, the detection of lamp current:

R3 – resistor, 1 MΩ

Lp1 – lamp

Lp2 – lamp

Dp – differential probe, < 10 pF

8.19 End-of-life test for integral, self-ballasted fluorescent lamps – one filament emission-mix-free test

8.19.1 A self-ballasted lamp shall be tested as described in 8.19.2 to 8.19.5.

8.19.2 Six samples shall be used for the test. Three of the samples shall have no emission-mix on one lamp filament and the other three samples shall have no emission-mix on the other lamp filament.

8.19.3 During the test, the device shall be energized at the input voltage and frequency. The device shall be oriented base up unless the packaging clearly indicates the bulb is not to be operated in this orientation. The samples may be operated in an open environment.

8.19.4 The samples shall be observed during the test for any evidence of smoke, fire, or cracking of the bulb wall. The test shall be discontinued upon any evidence of fire.

8.19.5 The results of the test comply with this Standard if:

a) Any flaming is contained in the enclosure,

b) There are no burn-through openings created in the enclosure,

c) There are no dislodged particles of glass larger than 3 mm (0.1 in),

d) The combined area of any charred black spots does not exceed 75 mm^2 (0.12 in^2) [not including the area described in (e)],

e) There is no charred black area around the tube wider than 3 mm (0.1 in) measured perpendicular to the bulb wall, and

f) No more than a small amount of smoke, similar to that of an overheated 1 W carbon resistor, is emitted.

8.20 15-VA available power measurement test

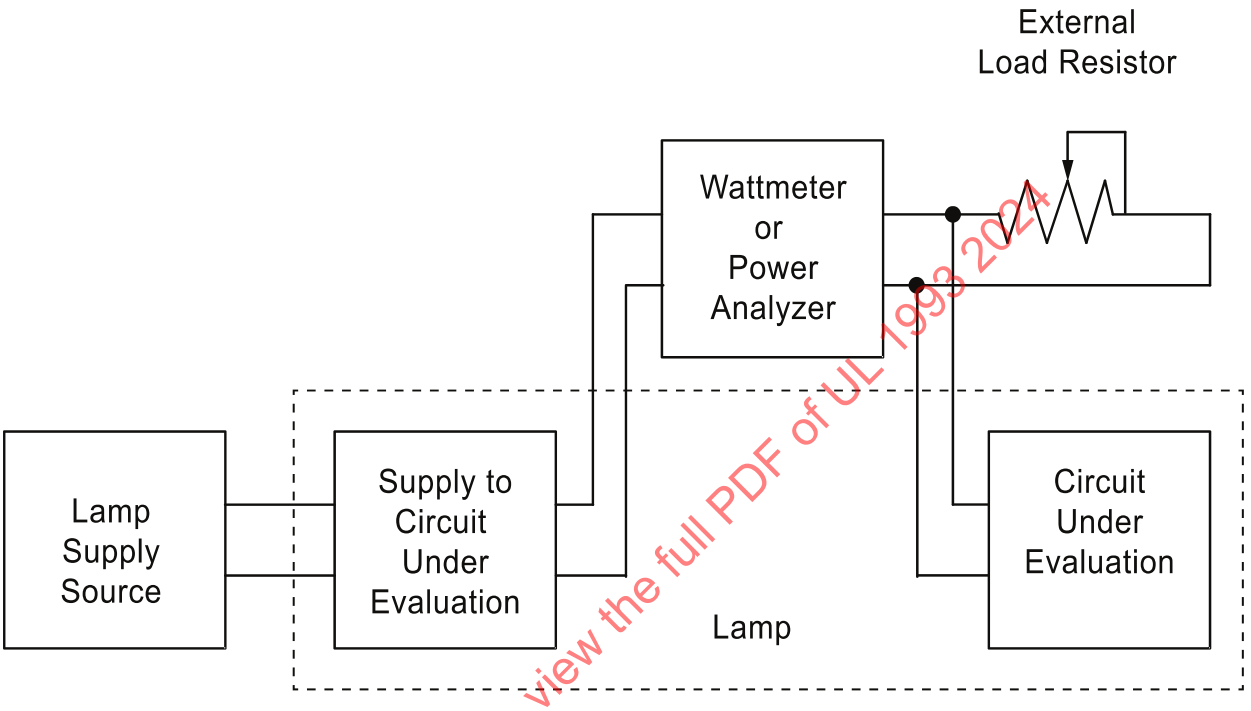
8.20.1 When evaluated per 8.20.2 – 8.20.7, the power available to a circuit is not considered to be a risk of fire if the maximum power available to the circuit is less than 15 VA under any loading condition, including short circuit, measured after one minute of operation.

8.20.2 The point in the circuit under evaluation shall be connected to the measurement circuit as shown in Figure 8.8. The external adjustable load resistor shall be initially set for its maximum resistance. The adjustable resistance shall then be reduced gradually to the point where 15 VA is being dissipated, and

adjusted as needed in an attempt to maintain 15 VA for one minute. If 15 VA cannot be maintained for one minute under any load condition, the test shall be discontinued.

Figure 8.8

Connection of Wattmeter



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8.20.3 If the supply to circuit under evaluation consists of other than a single resistor, the test described in 8.20.2 shall be repeated under any single component fault conditions within the supply circuit likely to result in greater output power availability. The fault condition shall first be applied, and then the variable resistance load shall be adjusted as needed. A new sample shall be used for each component fault.

8.20.4 With respect to 8.20.3, components for which the reliability against failure has been deemed acceptable by a separate evaluation shall not be faulted. Examples of such components include optical isolators evaluated to CSA Component Acceptance Service No. 5 or UL 1577; and capacitors evaluated to CSA-E60384 or UL 60384-14.

8.20.5 If the test is disrupted by the operation of a suitable protective component (e.g.: fuse, thermal link, fusible resistor, etc.) before one minute of operation, then the test can be discontinued.

8.20.6 If the test is disrupted by the failure of other circuit components (e.g.: capacitor, semiconductor, coil winding) then that test shall be repeated two additional times, with new samples, under the same test condition. Test disruption by opening of the same, or a different, component during these repeated tests is acceptable.

8.20.7 If there is any indication of component overheating during any of the tests described in 8.20.2 – 8.20.6 (e.g.: odor, smoke, discoloration, glowing, cracking, melting, or changes in circuit current through the fault), the test condition shall be repeated as part of either the Fault-Condition Test – Electronic

Ballasts – Class P Protection in UL 935 (for fluorescent ballast circuits) or the Component Failure Test in UL 8750 (for LED circuits), as applicable.

8.21 Moist ammonia air stress cracking test

8.21.1 After being subjected to the conditions described in 8.21.2 – 8.21.4, copper-alloy lamp bases shall show no evidence of cracking, delamination or degradation.

8.21.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and maintained during the test. Therefore, Edison screw lamp bases shall be inserted into nickel-plated or nickel alloy lampholders of the same fit designation and tightened to the torque specified by Table 8.3. All parts shall be clean and free from any oil or lubricant prior to insertion.

Table 8.3
Torque Values for Edison Screw Bases and Holders

Designation	Torque (N·m)
E39 (Mogul)	0.56
E29 (Admedium)	0.56
E26 (Medium)	0.56
E17 (Intermediate)	0.45
E12 (Candelabra)	0.34
E11 (Mini-candelabra)	0.34

8.21.3 Three samples, prepared per 8.21.2, are then to be tested in accordance with Apparatus (Clause 6), Reagents and Materials (Clause 7), Test Media (Clause 8), Test Sample Preparation (Clause 9.3 – 9.4), and Test Procedure (Clause 10.1 – 10.4) of the Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys, ASTM B858-06, with the test solution pH level High 10.5 ±0.1; exposure temperature of 25 ±1 °C; and with the examination in accordance with 8.21.4.

8.21.4 After the exposure period, the samples are to be examined for cracks or other signs of stress corrosion using a microscope having a magnification of 25X.

8.22 Evaluation of tack-soldered electrical connections

8.22.1 Part A – Loose connection

8.22.1.1 To determine if a cracked or otherwise unreliable solder joint is capable of hazardous arcing, the connection in question shall be subjected to the Arcing Test described in Annex D of UL 935 and clause 6.12.8 of CSA C22.2 No. 74.

8.22.1.2 For the test, the conductor to the soldered joint shall be cut and connected to the arcing tester. If needed, wire with the same or larger gauge may be used to extend the conductors just enough to secure to the tester's wiring terminals.

8.22.1.3 Three samples of each connection shall be tested in this fashion. The test results are considered acceptable if they comply with Clause D2.1.1 in UL 935.

8.22.2 Part B – Random contact

8.22.2.1 To determine if a loose conductor could cause a hazardous condition by contacting nearby surfaces or nearby electrical components, the conductor in question shall be disconnected from the solder joint and connected in turn to the various conductive surfaces and electrical components which it can physically touch should its soldered connection fail.

8.22.2.2 As these are considered abnormal conditions, this is conducted under the same conditions as the LED lamp and driver abnormal conditions tests in A8.22.

8.22.2.3 The test results are considered acceptable if they do not indicate a risk of fire or electric shock as defined in A8.22.2.

8.23 Joint endurance test

8.23.1 One sample of a lamp with movable joints containing conductors shall be tested. The joint shall be put through 100 cycles of motion in accordance with 8.23.2 or 8.23.3, at a rate of 24 – 40 cycles per minute (2 ±0.5 seconds/cycle), while energized from its intended supply source.

8.23.2 Joints with rotational stops shall be rotated through their entire range of motion then back to their starting point (e.g.: stop to stop) during each cycle.

8.23.3 Joints without rotational stops, such as those that employ brushes or conductive slip rings, shall be rotated for one revolution per cycle. This shall be done in one direction for half the required cycles, then in the opposite direction for the remaining cycles.

8.23.4 At the conclusion of this test, the joint shall be disassembled and examined. There shall be no evidence of physical damage or degradation to insulating components, nor arcing or pitting on any conductive parts.

8.24 Joint torsion test

8.24.1 One sample of a lamp with a movable joint and a rotational stop shall be tested. The torque specified in Table 8.4 shall be applied against the stop in each rotational direction for 5 seconds.

8.24.2 There shall be no damage to the lamp or its components as a result of this test.

Table 8.4
Test Values for Joint Torsion Test

Lamp base Designation[1]	Torque ±5 % N·m (lbf·in)
G5	0.23 (2)
G13, G20, Fa8, R17d	0.68 (6)
Single-ended pin-type[2]	0.68 (6)
E12, E17, GU10	1.13 (10)
E26, GU24	2.25 (20)
E39	3.39 (30)

[1] For non-tabulated lamp bases, use the value for the tabulated base most closely related in form and function.

[2] This applies to any single-ended lamp base that does not require a twisting motion to insert into or remove from its lampholder (i.e.: G23, GX24, etc.).

9 Test Apparatus

9.1 General

9.1.1 9.1 summarizes test equipment and environmental conditions needed for the laboratory facility where testing would be conducted.

9.1.2 Unless otherwise specified, the tests shall be carried out at an ambient temperature of 20 °C to 30 °C with a relative humidity between 30 and 70 %. Atmospheric pressure is not specified.

9.1.3 Test equipment shall be in a schedule of initial calibration and periodic re-calibration. The frequency of re-calibration for electronic instrumentation shall be as recommended by the instrument manufacturer, but not exceed 1 year between calibrations.

9.1.4 Test equipment shall have a method of specific identification, such as serial number or a unique laboratory numbering system, so that the equipment used for the test may be noted in the results of the test.

9.2 Instrumentation

9.2.1 The voltage in other than the supply circuit shall be measured using a voltmeter or voltmeter-multiplier combination having a resistance of not less than 10,000 Ω/V. Meters having higher input impedances shall be used if the impedance of the circuit under test warrants it. A voltmeter for measuring a supply circuit is not specified.

9.2.2 For determining values of voltage, a true rms indicating meter having a frequency response at least three times the frequency involved and having an adequate crest factor (ratio of peak to rms) shall be used. If applicable, consideration should be given to the DC component of the wave-shape. If a referee rms-voltage measurement is necessary, a meter with an input impedance of 10 MΩ shunted by 30 pF of capacitance shall be used.

9.2.3 If it is necessary to determine peak-voltage value, an oscilloscope with a high-impedance (10 MΩ minimum) input probe shall be used.

9.2.4 For thermocouple measurements, either a thermocouple potentiometer or an electronic instrument shall be used. An electronic instrument shall have an accuracy at least as good as the thermocouples described in 9.3.

9.3 Thermocouples

9.3.1 Thermocouples shall consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). It is standard practice to employ thermocouples consisting of 30 AWG iron-constantan (Type J) wires and a potentiometer-type or electronic instrument; and such equipment shall be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire shall conform to the requirements for thermocouples as listed in the table of special limits of error of thermocouples in ISA MC96.1.

9.3.2 Thermocouples consisting of chromel-alumel (Type K) or copper-constantan (Type T) wires may be used if it is determined that high-frequency ballast operation results in eddy current heating of iron-constantan thermocouples.

9.4 Plywood test box material

9.4.1 The plywood used for constructing temperature test boxes shall be 12-mm (1/2-in trade size) thick with at least one side that has all voids filled and sanded.

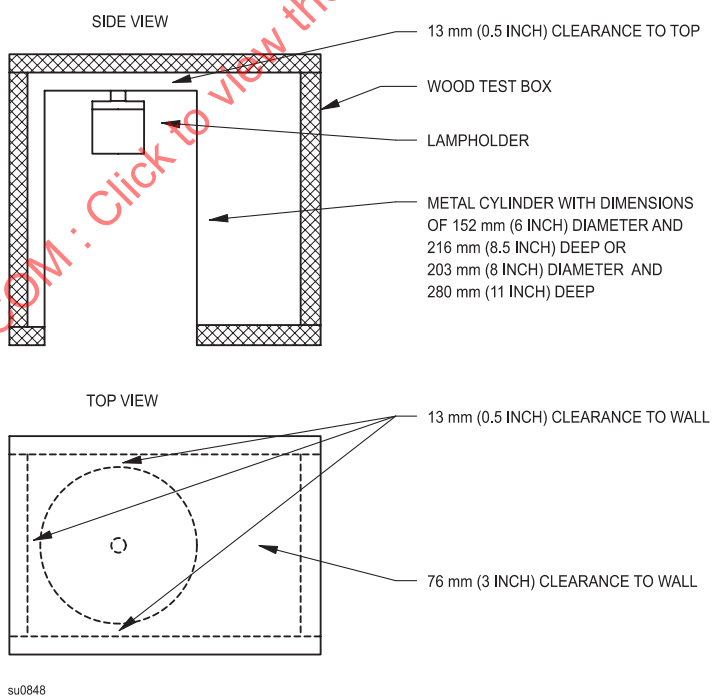
9.5 Temperature test box

9.5.1 Test apparatus for a device with an input rating less than 25 W

9.5.1.1 The test fixture shall be a steel or aluminum cylinder, closed at the top. The smaller cylinder shall be 152 mm (6 in) in diameter and 216 mm (8.5 in) deep, while the larger cylinder shall be 203 mm (8 in) in diameter and 280 mm (11 in) deep. The cylinders shall be fabricated of steel or aluminum, having a thickness between 0.76 and 1.27 mm (0.03 and 0.05 in). The cylinders shall be painted white on all sides. Each cylinder shall be installed in a rectangular test box having four sides, a top, and bottom. The cylinder shall be flush to the test box bottom and the wood bottom shall have an opening the size of the cylinder diameter. The test box sides shall be constructed of plywood described in 9.4.1. Three sides and the top shall be 13 mm (0.5 in) from the nearest part of the cylinder. The fourth side shall be 76 mm (3 in) from the nearest part of the cylinder. The supply lampholder shall be porcelain coated and have a cast metal cap bearing against the cylinder top. See Figure 9.1.

Figure 9.1

Small Temperature Test Box



9.5.2 Test apparatus for a device with an input rating greater than 25 W for an enclosed lamp compartment

9.5.2.1 The device shall be tested in the enclosed test fixture described below for the normal temperature test. The sides and top of the test fixture shall be constructed of 12.7 mm (1/2 in trade size)

thick minimum grade C-D or better plywood. The bottom shall be closed off with a 2.5 mm (0.1 in) thick piece of window glass of appropriate size.

9.5.2.2 The test fixture shall have a square cross-section. The dimensions of the sides of the square shall be specified by the self-ballasted lamp manufacturer and marked on the self-ballasted lamp. The dimensions shall be in millimetres. The height of the box shall be equal to the overall length of the self-ballasted lamp plus 13 mm (0.5 in).

9.5.2.3 A lampholder shall be mounted to the inside top of the center of the box and 0.82 mm^2 (18 AWG) insulated conductors of suitable temperature and voltage rating supply power shall be connected to it. The test fixture shall be suspended (by chain, cable, or similar means) in a draft-free room with the side of the test fixture closed off by glass facing the floor. The box shall be located so that each exterior surface is at least 1 m from the floor, walls, or ceiling of the draft-free test room.

9.5.3 Normal temperature test apparatus for a device with an input rating greater than 25 W for an open luminaire

9.5.3.1 The temperature test apparatus shown in Figure 9.2 shall be constructed as follows:

a) Wooden parts of the structure shall be secured together with wood screws or nails.

b) Wooden parts of the structure shall be as follows:

1) The face and back shall be plywood conforming to 9.4.1, 1.22 m (48 in) square.

2) The sides shall be 38 mm × 140 mm (2 in × 6 in trade size) wooden members.

3) The ends shall be 19 mm × 140 mm (1 in × 6 in trade size) wooden members.

4) The inside supports shall be 38 mm × 89 mm (2 in × 4 in trade size) wooden members.

c) A metal octagonal outlet box, 102 mm × 38 mm (4 in × 1-1/2 in trade size), shall be securely mounted in the center of the plywood panel, projecting through and flush with the outer face. One method for mounting the box is steel angle brackets, attached to opposite sides of the box and secured with wood screws to the inside of the plywood panel.

d) An optional metal surface utility box with cover may be mounted to the side of the structure to facilitate ease of making branch circuit connections. A 102 mm × 63.5 mm × 44.5 mm (4 in × 2-1/2 in × 1-3/4 in trade size) box has been found suitable for this purpose.

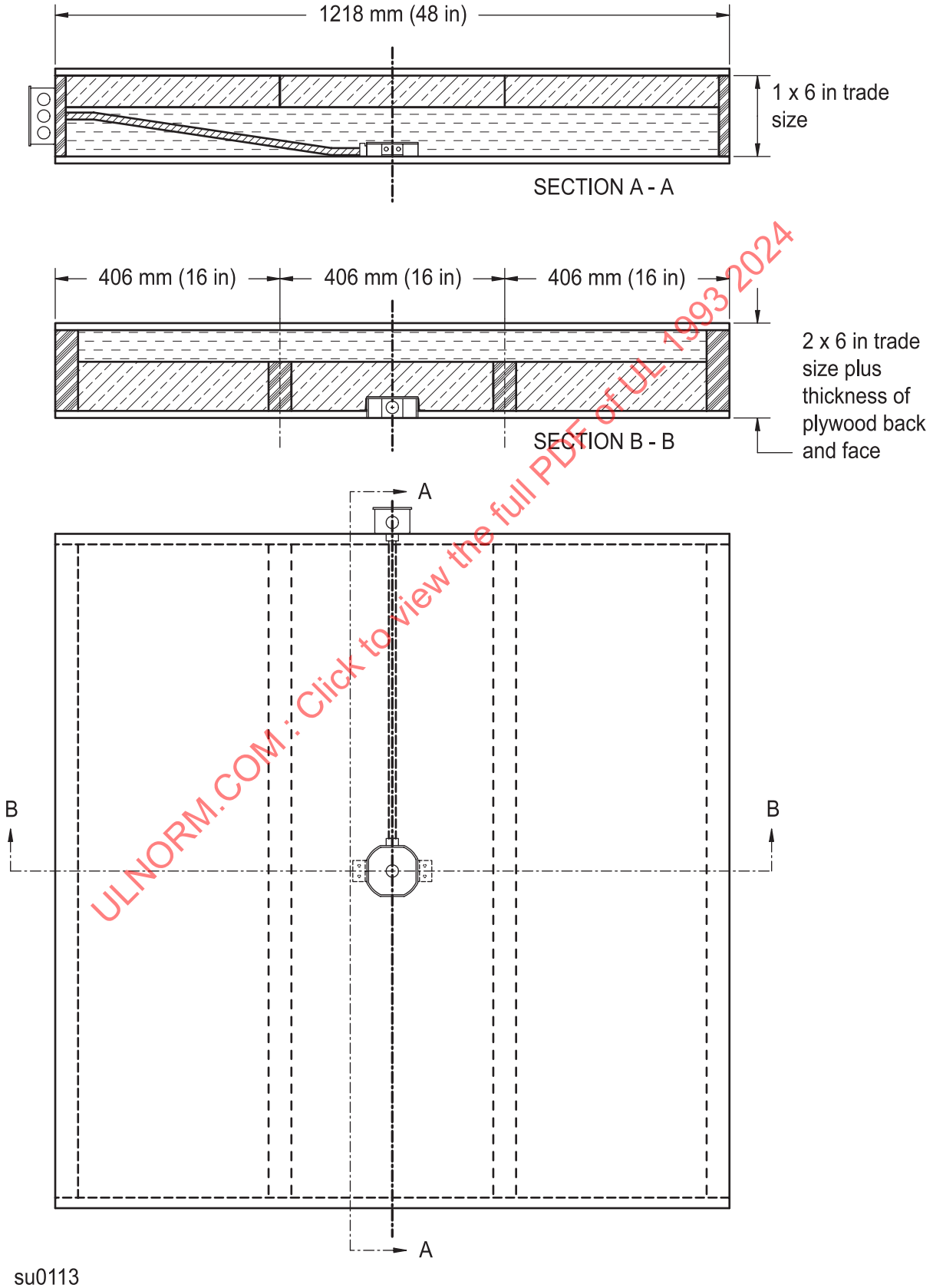
e) Flexible metal or non-metallic conduit may be installed between the outlet box and the utility box to facilitate replacing damaged conductors.

f) Wiring shall consist of one white and one black 2.08 mm^2 (14 AWG) conductor of any type and one 1.31 mm^2 (16 AWG) or larger conductor, bonding the boxes together.

g) The test ceiling apparatus shall be filled with two layers of faced or unfaced glass fiber insulation batts positioned at 90° to each other. The insulation batts shall be approximately 89 mm (3.5 in) thick and RSI 1.4 to RSI 1.9 (R8 to R11) positioned directly in contact with the outlet box and slit to completely surround the flexible metal conduit.

Figure 9.2

Insulated Test Ceiling for Devices Rated Greater Than 25 W and for an Open Luminaire

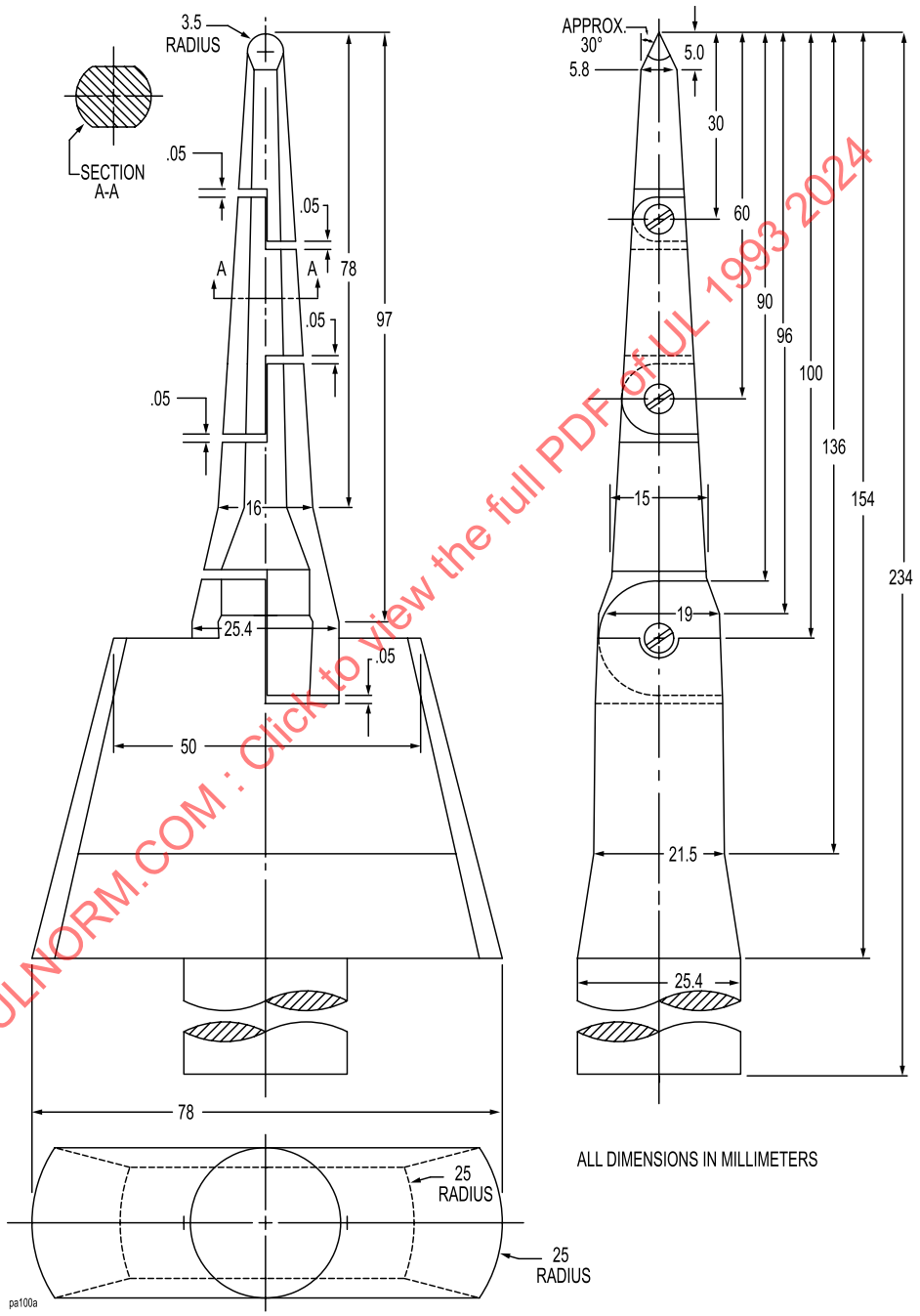


9.6 Articulated probe

9.6.1 See Figure 9.3 for articulated test probe specifications.

Figure 9.3

Articulated Test Probe

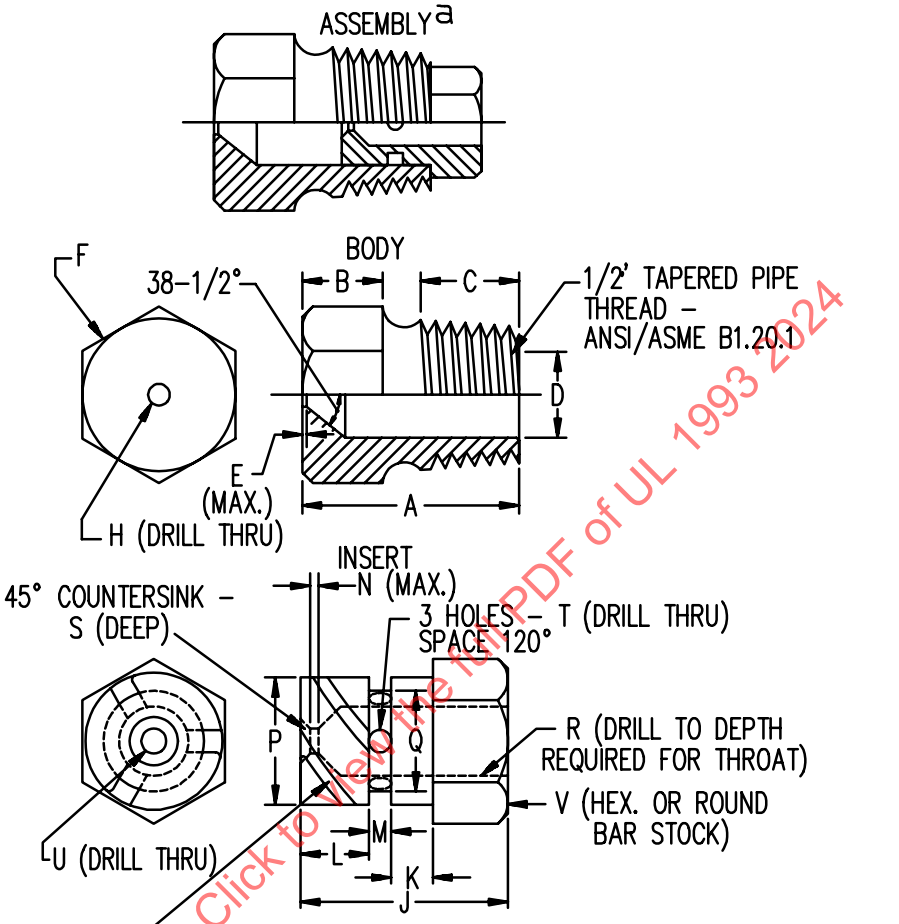


9.7 Water spray apparatus

9.7.1 The water spray test apparatus shall consist of three spray heads constructed in accordance with the details specified in Figure 9.4 and mounted in a water supply pipe rack as illustrated in Figure 9.5. The water pressure shall be maintained at each spray head at approximately 34.5 kPa (5 psi). The distance between the center nozzle and the device shall be approximately 1.4 m (4.59 ft). The device shall be brought into the focal area of the three spray heads in such a position and under such conditions that water will be most likely to enter, except that consideration shall be given to the normal mounting position.

Figure 9.4

Spray Head Assembly



Item	mm	inch	Item	mm	inch
A	31.0	1–7/32	N	0.80	1/32
B	11.0	7/16	P	14.61	.575
C	14.0	9/16		14.63	.576
D	14.68	.578	Q	11.51	.453
	14.73	.580		11.53	.454
E	0.40	1/64	R	6.35	1/4
F	c	c	S	0.80	1/32
G	1.52	.06	T	2.80	(No. 35) [b]
H	5.0	(No.9) [b]	U	2.50	(No. 40) [b]
J	18.3	23/32	V	16.0	5/8
K	3.97	5/32	W	1.52	0.06
L	6.35	1/4			
M	2.38	3/32			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

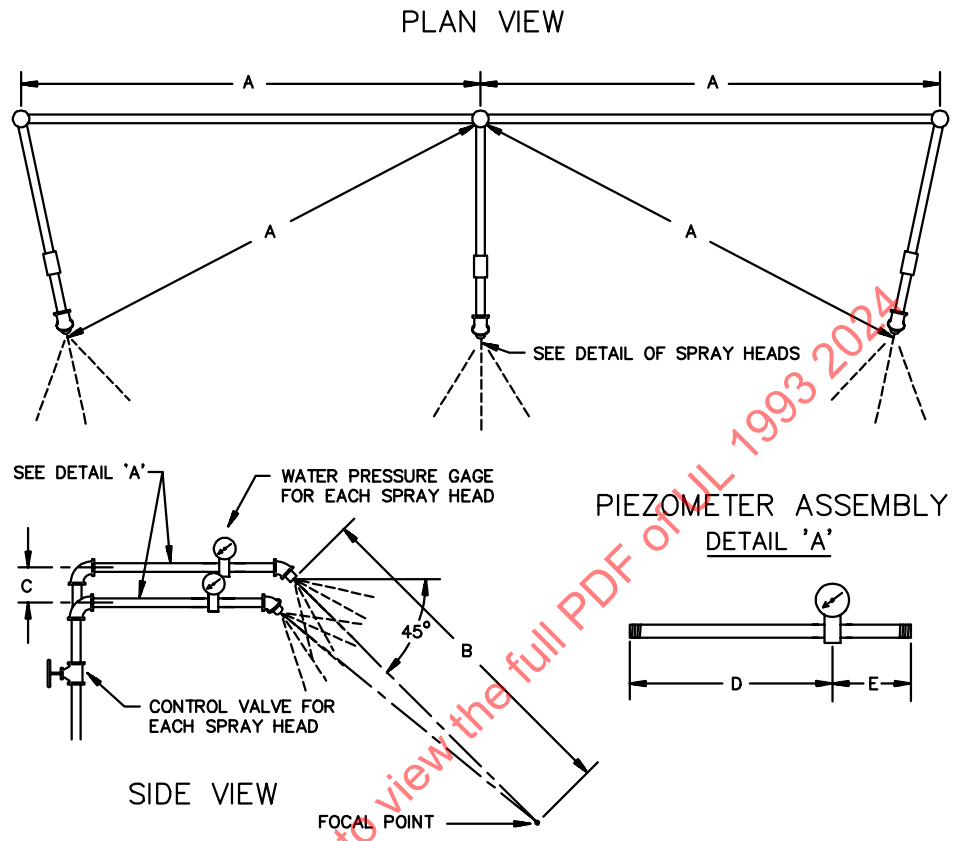
[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

RT100F

Figure 9.5

Spray Head Pipe Rack



Item	mm	inch
A	710	28
B	1400	55
C	55	2–1/4
D	230	9
E	75	3

RT101F

9.8 Cheesecloth

9.8.1 The cheesecloth shall be bleached cheesecloth, 914 mm (36 in) wide, running 26 to 28 m^2/kg (14 to 15 yd^2/lb) and having what is known in trade as a count 32 by 28. That is, for any square centimetre, 13 threads in one direction and 11 in the other direction (for any square inch, 32 threads in one direction and 28 in the other direction).

10 Device Markings

10.1 General

10.1.1 A device shall be legibly marked using one or more of the following methods:

a) Lettering on a pressure-sensitive label,

b) Ink-jet lettering,

c) Ink-stamped machine lettering,

d) Ink-hand stamped lettering,

e) Indelibly printed lettering,

f) Die-stamped lettering,

g) Molded (recessed) or embossed (raised) lettering,

h) Molded-or cast lettering,

i) Etched lettering in metal,

j) Laser printing, and

k) Silk screening and transfer printing.

10.1.2 A pictogram in accordance with Annex F may be used as a substitute for the corresponding text of Table 10.1 and shall be the subject of special inspection. When a pictogram is used instead of text marking on a device, the pictogram, along with the corresponding text, shall appear on an instruction sheet or device packaging.

10.1.3 A marking shall be of the minimum size (S____) and in the location (L____) shown in the “Format” column of Table 10.1 and as defined in Table 10.2 and Table 10.3.

10.1.4 “Verbatim” in the “Text” column of Table 10.1 indicates that the marking shall consist of only the exact words shown or a marking including these words and conveying the original intent. Alternative wording for other markings in the table may be used subject to evaluation.

In Canada, bilingual marking is the jurisdiction of Canadian provincial regulatory authorities, which may require marking to also be in French, as shown in Annex H.

In Mexico, all markings shall include Spanish, as shown in Annex I.

10.1.5 All markings shall have lettering in which:

a) The precautionary signal word (Item 8) is at least 2.0 mm (0.08 in) high,

b) The text is at least 1.3 mm (0.05 in) high and contrasting in color to the background, and

c) If molded or stamped in a material, the text is at least 2.0 mm (0.08 in) high, and if not contrasting in color, a depth or raised height of at least 0.5 mm (0.02 in).

10.1.6 Pressure-sensitive labels of the permanent type (Type P) that are secured by adhesive shall be in accordance with CSA C22.2 No. 0.15 or UL 969. The adhesive of the pressure-sensitive labels shall be suitable for the application surface, temperature, and environment.

10.2 Identifications and ratings

10.2.1 A device shall be marked with the following:

a) Identification of the company responsible for the product, in accordance with Table 10.1, Item 1. The identification may be in a traceable code if the device is identified by a brand or trademark owned by a private labeler.

b) A catalog number, model number, series number, or other similar designation in accordance with Table 10.1, Item 2,

c) A date code or other dating period of manufacture not exceeding any three consecutive months, in accordance with Table 10.1, Item 3. The date marking may appear on the surface of the device or lamp base screw shell and may be abbreviated or appear in a nationally accepted conventional code or in a code affirmed by the manufacturer, if it:

1) Does not repeat in less than 10 years, and

2) Does not require reference to the production records of the manufacturer to determine when the product was manufactured, and

d) Factory identification, if more than one location, in accordance with Table 10.1, Item 4.

Table 10.1
List of Required Markings

Item	Product markings	Text	Format	Text reference
1	**Manufacturer's identification**		S13L1	10.2.1(a)
2	**Catalog number or similar product designation**		S13L1	10.2.1(b)
3	**Date marking (may be in code)**		S13L1	10.2.1(c)
4	**Factory identification, if more than one (may be in code)**		S13L1	10.2.1(d)
5	**____ VOLTS____ AMPS _____ WATTS ____ HERTZ or ____ V _____ A ____ W ____ Hz**		S13L1	10.2.2
6	**USE WITH LAMP OF _____ WATTS**		S13L1	10.2.3
7	**HIGH POWER FACTOR or HPF**		S13L1	10.2.4
8	**CAUTION**	Verbatim	S20L1	6.10.1, 6.10.2(a)
9	**RISK OF ELECTRIC SHOCK – USE IN DRY LOCATION ONLY or ELECTRIC SHOCK RISK – ONLY FOR DRY LOCATIONS**	Verbatim or Symbol	S13L1	7.1.1, 10.2.7
10	**SUITABLE FOR DAMP LOCATIONS, or FOR DAMP LOCATIONS, or RISK OF ELECTRIC SHOCK – DO NOT USE WHERE DIRECTLY EXPOSED TO WATER**	Verbatim or Symbol	S13L1	7.2.1, 10.2.7

Table 10.1 Continued on Next Page

Table 10.1 Continued

Item	Product markings	Text	Format	Text reference
11	**SUITABLE FOR WET LOCATIONS or FOR WET LOCATIONS**	Verbatim or Symbol	S13L1	7.3.1, 10.2.7
12	**SUITABLE FOR WET LOCATIONS – (to be followed by words describing the restricted positioning) as tested in 8.15, "SUITABLE" is optional**	Text or Symbol	S13L1	7.3.1, 8.15.1, 10.2.7
13	**DO NOT USE WITH DIMMERS or NOT FOR USE WITH DIMMERS**		S13L1	8.13.1.2
14	**DO NOT USE WITH STANDARD DIMMERS, SEE INSTRUCTIONS**		S13L1	8.13.1.3
15	**NOT FOR USE IN TOTALLY ENCLOSED LUMINAIRES or NOT FOR TOTALLY ENCLOSED LUMINAIRES**	Text or Symbol	S13L1	8.5.9, 10.2.5, 10.2.7
16	**MAX___WATTS TYPE _____ SHIELDED or** **MAX ____ W TYPE ___ SHIELDED (for adapters with tungsten-halogen lamps)**	Verbatim	S20L1	6.10.2
17	**MAX___WATTS TYPE _____or** **MAX ____ W TYPE ___ (for adapters with tungsten-halogen lamps)**	Verbatim	S20L1	6.10.1
18	**SUITABLE FOR OPEN LUMINAIRES (for adapters with tungsten-halogen lamps)**	Verbatim	S13L1	6.10.3
19	**"Hg" (In a circle)**	"Hg" verbatim, circle is a graphical element	S20L1	10.2.6
20	"Mercury disposal: epa.gov/cfl"	Verbatim	S20L1	10.2.6
	Instructions General			
21	**ADDED WEIGHT OF THE DEVICE MAY CAUSE INSTABILITY OF A FREE-STANDING PORTABLE LUMINAIRE**		L2	10.4.1
22	**USE ONLY WITH A PORTABLE TABLE LUMINAIRE THAT IS PROVIDED WITH A SHADE**		L2	10.4.1
23	**USE IN PORTABLE TABLE LUMINAIRES IN WHICH THE DISTANCE FROM THE BOTTOM OF THE BASE TO THE TOP OF THE LAMPHOLDER DOES NOT EXCEED THREE (3) TIMES THE MINIMUM BASE DIAMETER**		L2	10.4.1, 10.4.3
24	**THIS DEVICE IS NOT INTENDED FOR USE WITH EMERGENCY EXITS or NOT FOR EMERGENCY LIGHTING**		L2	1.5 and 10.4.4
25	**SUITABLE FOR USE IN ENCLOSED LUMINAIRES**	Verbatim	S28L1	8.5.6(e)
26	**MIN. LAMP COMPARTMENT DIMENSIONS _(L)_ x (W)_ mm**	Verbatim	S28L1	8.5.6(e)
27	**USE IN OPEN LUMINAIRE ONLY**	Verbatim	S28L1	8.5.6(e)
28	**USE ONLY IN MODEL (model number) MANUFACTURED BY (manufacturer)**	Verbatim	S28L1	8.5.6(e)
29	**"Hg" (In a circle)** **"LAMP CONTAINS MERCURY"** **www.lamprecycle.org or www.epa.gov/bulbrecycling** **(Optional) "Manage in Accord with Disposal Laws"**	"Hg" verbatim, circle is a graphical element	S20L2	10.2.6
30	**"Contains mercury, For more on cleanup and safe disposal, visit epa.gov/cfl"**	Verbatim	S20L2	10.2.6
31	**Suitable for luminaires rated __ °C ambient**	Verbatim	S13L1, S13L2, or both	8.5.18

Note: The text shown in the table does not represent the actual minimum size and typestyle required. Text in parentheses ( ) is descriptive or informative and not part of the actual marking notice.

Table 10.2
Format Minimum Size Designations for Marking Height and Type Face

Size designation	Letter height mm (in)	Font size	Font type face uppercase
S13	1.3 (0.051)	5	Universal bold Arial bold Helvetica bold Zurich BT bold Sans Serif
S20	2.0 (0.079)	7.5	
S28	2.8 (0.110)	11	

Table 10.3
Format Location Designation for Marking

Location designation	Description	Marking
L1	On the product	Type P
L2	On smallest unit packaging, point-of-sale package, carton, or instruction sheet	Type T

Notes:

Type P designates a permanent marking that is intended to remain in the applied position for the lifetime of the device under conditions of normal use. It provides information required for the user maintenance over the expected life of the device. If a label is used, it must be made of material that complies with 10.1.6.

Type T designates a temporary label, instruction sheet, or tag that provides installation instruction and information not required after installation. It is made of printed matter with or without attachment to the device.

10.2.2 A device shall be marked with an electrical input rating in volts, hertz, wattage, and current in accordance with Table 10.1, Item 5. Hertz can be omitted if volts is expressed as “VAC” and the device has been evaluated for 60 Hertz, or if volts is expressed as “VDC.”

10.2.3 A lamp adapter shall be marked with a wattage rating as specified in Table 10.1, Item 6.

10.2.4 A device with a power factor rating greater than 0.90 may be marked in accordance with Table 10.1, Item 7.

10.2.5 Unless the device is tested with the lens as described in 8.5.9, the device shall be marked in accordance with Table 10.1, Item 15.

10.2.6 In the United States, self-ballasted fluorescent lamps shall be marked as described in Table 10.1, Item(s) 19, 20 or both. The smallest unit packaging, point-of-sale package, carton, or “stuffer sheet” packed with a lamp shall contain the marking described in Table 10.1, Item(s) 29, 30 or both.

In Canada and Mexico, these requirements do not apply.

10.2.7 When a marking in Table 10.1 has a corresponding symbol in Annex F and instructions are included on the packaging explaining the pictogram's meaning, the symbol may be used in place of the corresponding text in Table 10.1.

10.3 Marking requirements in Mexico

10.3.1 In Mexico, markings and labels on devices or packaging shall meet the requirements of 10.3.2 to 10.3.4 as applicable.

10.3.2 In Mexico, markings and labels on devices or packaging shall meet the following requirements:

a) The use of a period as a decimal point shall not be used. A comma shall be used as a decimal point.

b) Magnitudes less than the unit shall be represented with a zero followed by #, where # equals magnitude (for example, 90 cm = 0,90 m).

c) Letter size shall not apply to any marking.

d) Where applicable, input voltages (V) and current symbols shall be:

1) c.a. or AC or ~

2) c.d. or DC.

10.3.3 In Mexico, devices shall be marked with the following:

a) The name or trademark, model, or manner in which the manufacturer or importer identifies the product,

b) Nominal input voltage, frequency, wattage, and current,

c) Date marking or code form,

d) The type of lamp and wattage in watts for adapters, and

e) A statement that identifies the origin of the product.

Notes:

1) The frequency can be omitted if the ballast is an electronic circuit that works independently of the input frequency within an interval from 50 Hertz to 60 Hertz.

2) If the product is marked with the input wattage and the power factor is 0,9 or greater, the current can be omitted.

3) The manufacturing date can be brief or use a code designated by the manufacturer.

f) A device that is not intended to be used in a dimming circuit shall be marked “Do not use with dimmers.”

g) A device can be marked as “High Power Factor” or “HPF” if the power factor measured is 0,9 or greater.

10.3.4 In Mexico, the packaging shall include the following:

a) The graphical representation or product name, unless this is obvious,

b) The national manufacturer or importer’s name, address, telephone number, and telex number,

c) The name or trademark, model number, or manner in which the manufacturer or importer identifies the product,

d) Nominal input voltage, frequency, wattage,

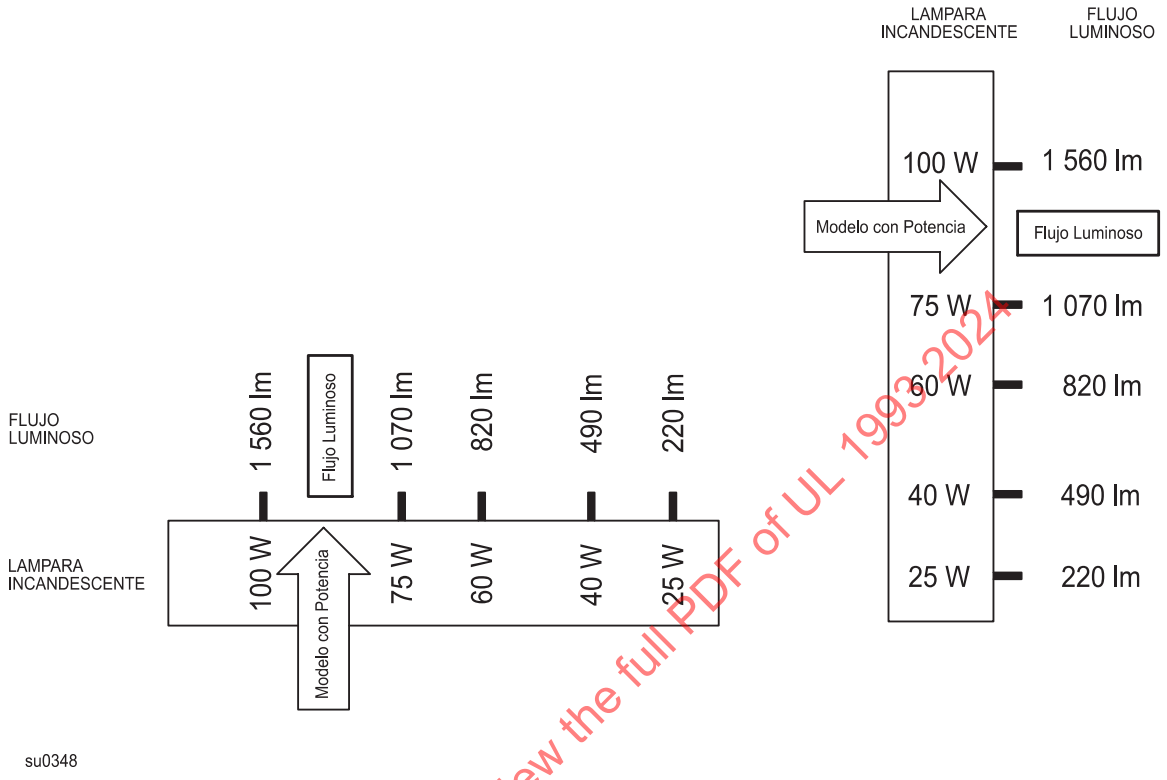
e) Number of pieces per carton.

f) Comparative graphic scale that indicates the equivalence with respect to incandescent lamps being replaced, with exception of reflector type lamps (see Figure 10.1), and

g) Average lamp life expressed in hours.

Figure 10.1

Graphic Scale of Luminous Flux



10.4 Instructions

10.4.1 A device weighing over 200 g (0.44 lbs) shall be provided with instructions in accordance with Table 10.1, Items 21 and 22.

10.4.2 A device, typically not intended for use in free-standing portable luminaires, such as a PAR- or R-shaped bulb, is not required to comply with 10.4.1.

10.4.3 A device employing a lamp, such as a circular lamp, that extends outside of the harp of a portable luminaire shall be provided with an instruction in accordance with Table 10.1, Item 23, or shall be marked as required by 10.4.1.

10.4.4 The instructions shall include the statement in Table 10.1, Item 24.

10.4.5 The instructions for a device marked in accordance with Table 10.1, Item 14, shall include the following or equivalent statement: "Only use the control provided with or specified by these instructions to control this lamp. This lamp will not operate properly when connected to a standard (incandescent) dimmer or dimming control."

ANNEX A
(normative)

Supplemental Requirements for Light-Emitting Diodes (LED)

A1 Scope

A1.1 Section 1 applies and as amended below.

A1.2 The text in the main body of this Standard, along with this Annex, make up requirements for devices employing light-emitting-diode (LED) lamp technologies.

A1.3 Where the requirements of any of the clauses of the main text are referenced in this Annex by the phrase “The requirements of clause ___ apply”, this phrase is to be interpreted as meaning that all requirements of the clause or paragraph of main text apply, except where it is clearly non-applicable to the product being evaluated.

A1.4 The text in the main body of this Standard using the word “ballast” is understood to also comprise LED drivers. The text in the main body of this Standard using the word “lamp” is understood to also comprise LED arrays.

A1.5 At various points in this Annex references are made to UL 8750 or CSA C22.2 No. 250.13.

A1.6 These requirements cover:

a) Self-contained LED lamps, with control circuitry and driver, rated up to 347 V nominal for connection to screw-, pin-base, and recessed single contact (RSC or R7) lampholders,

b) Devices 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 – see A6.13, and,

c) Component LED lamps, with or without control circuitry, an ANSI base other than bases mentioned in (1), for connection to LED driver having a low voltage output, such as replacement for tungsten-halogen, MR11 and MR16 shaped lamps – see A6.14.

A1.7 These requirements do not cover LEDs that are integral components and which form a non-replaceable part of a luminaire and which cannot be tested separately from the luminaire.

A1.8 LED light sources having a means of supply connection other than lamp bases described above, are evaluated using requirements in UL 8750 or CSA C22.2 No. 250.13.

A2 Reference Publications

A2.1 Publications from Section 2 apply.

A3 Definitions

A3.1 Terms from Section 3 apply and as amended below.

A3.2 BASIC INSULATION – electrical insulation of fiber or other polymeric material. Fiber and polymeric insulating materials are evaluated for moisture and puncture resistance, and electrical dielectric properties. Polymeric materials are additionally evaluated for electrical support properties sufficient for the application.

A3.3 BARRIER – a part of the device intended to physically limit access to parts that pose a risk of electric shock. A barrier can be an insulating material in contact with other conductive parts or a conductive material isolated from other conductive parts.

A3.4 CIRCUIT, CLASS 2 – a circuit of a low voltage and limited power nature such that the circuit components can be installed with the simplified installation manner described in Article 725 of the NFPA 70 for the United States, or Section 16 of Canadian Electrical Code, Part I, in Canada. The circuit supplied by an isolating source complies with the electrical limits and test requirements of:

a) UL 1310, or the Class 2 requirements of the UL 5085-3 for the United States, or

b) CSA C22.2 No. 223, or the Class 2 requirements of the CSA C22.2 No. 66.1 for Canada.

Note: For the purposes of this Standard, Limited Power Sources complying with UL 60950-1 or CSA-C22.2 No. 60950-1 are deemed to be equivalent to Class 2 power supplies with respect to risk of electric shock and risk or fire.

A3.5 DIRECT CURRENT (DC) – a voltage or current waveform where the instantaneous value does not vary.

A3.6 LED ARRAY (LED MODULE) – an assembly of one or more discrete LED electronic components on a printed circuit board, typically with optics and additional thermal, mechanical, and electrical interfaces.

A3.7 LED DRIVER – a power source and control circuitry to control the voltage or current to LEDs. The control circuitry can range from a simple (bridge rectifier and resistor) to complex (incorporating power factor control, constant voltage or constant current outputs, and the like).

A3.8 LED LAMP, COMPONENT – an LED device without integral power source and with an ANSI standardized base designed for connection to a luminaire. The bulb can take the shape of an incandescent lamp it is intended to replace, such as MR-16.

A3.9 LED LAMP, SELF-CONTAINED (INTEGRATED) – a device with an LED array, an integrated driver, and an ANSI standardized base that is designed to connect to a supply branch circuit via an ANSI standardized lampholder. In North America, a “standardized base” refers to an ANSI standard base.

Note: In Canada, tubular self-contained LED lamps may be connected to non-ANSI standardized lampholders that are approved for the application.

A3.10 LED LENS, INTEGRAL – the optical element integral to an LED package that focuses or diffuses the light from the LED die(s). Optical assemblies secured to the LED package after package manufacture (such as during the assembly of an LED array) are not considered integral LED lenses.

A3.11 LINEAR LED LAMP – A double-ended self-contained LED lamp intended for direct connection to a voltage-controlled power source (i.e.: branch circuit, low-voltage transformer, etc.) and provided with ANSI standardized LED lamp bases. This excludes lamps with bases traditionally associated with fluorescent lamps (e.g.: G5, G13, G20, Fa8 and R17d).

A3.12 POLARIZATION – observing the identification of the grounded supply conductor for electrical connection of certain components in order not to increase the risk of electric shock. (Not related to polarization of light.)

A3.13 RETROFIT LUMINAIRE CONVERSION – the act of modifying, with additional parts, a luminaire that was already manufactured and in service in order to convert the luminaire to an LED light source, from an incandescent, fluorescent, or high intensity discharge light source. For this Standard, direct replacement of an incandescent to LED lamp, without any electrical or mechanical changes, is not considered to be a luminaire conversion.

A3.14 WORKING VOLTAGE – the highest voltage to which the insulation under consideration is or can be subjected when the equipment is operating at its rated voltage under conditions of normal use.

A3.15 USE, GENERAL – a device that has been determined acceptable for direct installation in field applications in accordance with country-specific national electrical codes. A device complying with the requirements of this Standard is considered to be for general use.

A3.16 USE, SPECIAL – a device intended as a component of a luminaire or a unique application and subject to additional considerations when the final application is known. A device complying with the requirements of this Standard and any additional requirements for the final application is considered to be for special use.

A4 General Requirements

A4.1 Requirements from Section 4 apply.

A5 Mechanical Construction

A5.1 Enclosures

A5.1.1 Requirements from 5.1 apply and as amended below.

A5.1.2 Lamp enclosures can be partially or entirely of glass. Glass is considered to be an inorganic material that can vary considerably in mechanical strength and resistance to cracking or breaking. Requirements in this Annex evaluate the material for lamp applications.

A5.2 Openings

A5.2.1 Requirements from 5.2 apply and as amended below.

A5.2.2 No openings are permitted for devices designated for wet locations.

A5.3 Polymeric materials

A5.3.1 Requirements from 5.3 apply and as amended below.

A5.3.2 The enclosing diffuser for an LED shall have a flammability rating as indicated in Table A5.1. Different flammability ratings are assigned depending on the power available to the LED array and whether the LED driver has an isolated or direct connected output – see A6.4.

Table A5.1
LED Lens and Diffuser Flammability Ratings

Power source	Class 2[a]	Isolated, non-Class 2[b]	Direct connected
Enclosure type needed	**None**	**Fire**	**Fire and electrical**
Integral LED Lens	Not defined	V1	V1
Other lenses and diffusers	Not defined	V0[c]	V0

[a] Power sources that also fall into this category include:

1) Limited Power Sources (LPS) compliant with UL 60950-1 or CSA C22.2 No. 60950-1,

2) Low Voltage, Limited Energy (LVLE) power sources compliant with UL 8750 or CSA C22.2 No. 250.13, and

3) Power sources not considered a risk of fire per 4.5.2.

Table A5.1 Continued on Next Page

Table A5.1 Continued

Power source	Class 2[a]	Isolated, non-Class 2[b]	Direct connected
Enclosure type needed	None	Fire	Fire and electrical

[b] Power sources isolated from the mains that are not a risk of shock (per 4.5.1) also fall into this category.

[c] May be V1 or SC1 if the total volume of all diffusers is less than 2500 mm^3 (0.156 in^3). The flammability of small parts may alternatively be determined using UL 1694.

A5.3.3 A polymeric sheet insulating material used between a live part and an accessible non-current-carrying metal part, such as a heat sink, shall comply with the applicable requirements of this clause and is considered basic insulation.

A5.3.4 A conductive coating applied to a surface such as the inside surface of a cover, enclosure, reflector, or the like shall comply with the requirements for metallized parts in UL 746C.

Note: This does not apply to coatings applied to compartments or in locations where the electrical parts would represent neither a risk of fire nor a risk of electric shock if they were to come into contact with conductive debris under any condition of use.

A5.3.5 An adhesive used to secure the enclosure of a product that poses a risk of electric shock or risk of fire shall comply with the adhesive support test of UL 8750 or CSA C22.2 No. 250.13. Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are not subject to this test.

A5.4 Weight and moment

A5.4.1 Requirements from 5.4 apply and as amended below.

A5.4.2 Requirements from 5.4 apply only to the lamps with the bases specified in 5.4.

A5.4.3 Unless there is provision to support additional mass (weight) so the device is not solely supported by general use lampholders, a device supported only by a pair of pin bases and holders (A6.13) shall have a mass (weight) not more than:

a) 0.2 kg (7 oz or 0.44 lbs) when using a G5 base, or

b) 0.5 kg (17.6 oz or 1.1 lbs) when using a G13 base.

A5.4.4 A GZ4 or G5.3 lampholder for low voltage lamps is not intended to support the mass (weight) of the lamp, so there is no specified value.

A6 Electrical Construction

A6.1 Lamp bases and lampholders

A6.1.1 Requirements from 6.1 apply and as amended below.

A6.1.2 A lamp with other than an Edison screwbase shall have a base that complies the dimensions of a base described in ANSI C81.61.

A6.1.3 Certain ANSI pin bases are designated for low voltage (< 30 V). See UL 1598 or CSA C22.2 No. 250.0 for a listing of the low voltage bases.

A6.1.4 For devices substituting for linear fluorescent lamps, A6.13, some contacts for the G5 or G13 lamp bases are not used for electrical connections and will only be intended for mechanical support of the lamp. Such contacts shall have no connection, and, if two unused contacts are in a single lamp base, the

contacts shall not be connected (short-circuited) together or be connected (short-circuited) to any dead metal part of the lamp base. These devices shall be subjected to the Isolation of lamp pins, A8.20.

A6.2 Current-carrying parts

A6.2.1 Requirements from 6.2 apply and as amended below.

A6.2.2 For devices substituting for linear fluorescent lamps, Type C, the supply and the output (even if designated Class 2) wires connected to the LED driver shall be rated 300 V minimum, 90 °C minimum since separation of supply and output wires cannot be assured in installation.

A6.3 Printed circuit boards

A6.3.1 Requirements from 6.3 apply and as amended below.

A6.3.2 Printed circuit boards shall comply with UL 8750 or Annex E.

A6.3.3 In the United States, flexible material printed wiring board constructions shall comply with UL 796F.

In Canada and Mexico, this requirement does not apply.

A6.3.4 Circuit conductors can be placed on an alumina ceramic material similar to conventional printed wiring boards. The ceramic material is inorganic so there is no flame resistance rating assigned. The usage temperature limit of the ceramic material is much higher than the semiconductor junctions that will be mounted to the ceramic. The suitability of the bonding of the circuit conductors shall be determined by tests specified in UL 796. Foil circuit conductors shall be subjected to Bond Strength tests. Conductive paste conductors shall be subjected to the Conductive Paste Adhesion tests.

A6.4 Ballasts and LED drivers

A6.4.1 Requirements from 6.4 apply and as amended below.

A6.4.2 6.4.1 – 6.4.4 pertain to fluorescent ballast construction and are not applicable to LED drivers. 6.4.5 – 6.4.7 are applicable to ballasts and LED drivers. 6.4.8 is applicable to LED drivers.

A6.4.3 Drivers for LEDs have outputs that are categorized as:

a) Class 2 circuit,

b) Isolated from the supply, but above the Class 2 circuit limits, or

c) Direct (Non-isolated, regardless of the supply voltage).

A6.4.4 The construction of the LED driver circuitry shall comply with the appropriate requirements of UL 8750 or CSA C22.2 No. 250.13.

A6.4.5 The LED driver shall comply with the component fault condition tests described in A8.22.

A6.5 Power capacitors

A6.5.1 Requirements from 6.5 do not apply.

A6.6 Spacing of electrical parts

A6.6.1 Requirements from 6.6 apply and as amended below.

A6.6.2 Spacing at a lamp base for some ANSI configurations may be less than, and would supersede dimensions in the main text.

A6.6.3 For devices for connection to a low voltage (< 30v) supply, UL 8750 or CSA C22.2 No. 250.13 requirements apply.

A6.7 Accessibility of live parts

A6.7.1 Requirements from 6.7 apply.

A6.8 Light source – fluorescent lamps

A6.8.1 Requirements from 6.7 apply.

A6.9 Light source – light emitting diodes (LED)

A6.9.1 Requirements from 6.9 apply and as amended below.

A6.9.2 LED light sources shall comply with UL 8750 or CSA C22.2 No. 250.13, as appropriate.

A6.9.3 An LED array that is accessible, as determined by a lack of enclosure or as a result of mechanical testing of the lens or enclosure, shall not result in a risk of electric shock. Mechanical testing would include Drop Impact (8.8 or 8.16), Mold-stress Conditioning (8.9), and Humidity Conditioning (8.14) if rated damp or wet locations.

A6.9.4 An LED array that is inaccessible, including results for mechanical testing as noted in A6.9.3, can be powered by a direct output type LED driver or an isolated type supply where the voltage would exceed electric shock hazard limits.

A6.10 Light source – non-discharge lamps

A6.10.1 Requirements from 6.10 do not apply.

A6.11 Grounding

A6.11.1 Accessible non-current-carrying metal parts that could be energized from within and where the voltage is greater than 150 V shall be bonded to ground or be made inaccessible.

A6.11.2 In lieu of grounding, devices may be double insulated in accordance with A6.16.

A6.11.3 A connector provided with a contact, or pole, for grounding shall arranged so the connection is the last connection to disconnect (first to make, last to break).

A6.12 Polarization

A6.12.1 A loss of polarization shall not introduce a risk of electric shock.

A6.13 Devices substituting for linear fluorescent lamps

A6.13.1 The requirements in this clause apply to LED devices that have the general appearance, length, and base types of a conventional fluorescent lamp. These devices have the physical dimensions of a lamp described in NEMA C78.81. The following constructions are considered by these requirements:

a) **Type A** – A device for general-use is intended for direct substitution of a fluorescent lamp and operating from the ballast that would be provided for the fluorescent lamp without additional modifications of the fluorescent lamp circuit.

b) **Type B** – A device for special-use intended for operation in luminaires that are either factory wired especially for the device or as a component for retrofit luminaire conversions involving modification of an existing luminaire, and the LED driver components are an integral part of the device.

c) **Type C** – A device for special-use intended for operation in luminaires that are either factory-wired especially for the device or as a component for retrofit luminaire conversions involving modification of an existing luminaire, and the LED driver components are remote from (or not an integral part of) the device.

Note: The above type designations are just for use in this Standard.

A6.13.2 A device that substitutes for a linear fluorescent lamp shall comply with the Risk of Electric Shock – Relamping test, see A8.19. A Type C device powered from a remote LED driver and having a voltage of less than 30 volts need not be subject to this test.

A6.13.3 Type A devices shall comply with Annex C.

A6.13.4 A Type B or C device for special use as a component for retrofit luminaire conversions shall additionally comply with installation instructions described in UL 1598C or CSA C22.2 No. 250.1-16.

A6.13.5 Type B and C devices shall have the source of electrical supply applied either at one of the lamp bases or across the lamp at both lamp bases and the connections will be incompatible unless a special evaluation can show the device can be powered in either method. See A8.21 for misapplication testing and A10.2.3 for product marking.

A6.13.6 Type C devices shall be for direct or alternating current operation and will be incompatible unless a special evaluation can show the device can be powered in either method. See A8.21 for misapplication testing and A10.2.3 for product marking.

A6.13.7 Type C devices shall have a correlated marking regarding the lamp and remote LED driver the devices are intended to work with:

a) For the linear LED lamp operating with a remote LED driver, the lamp shall be marked in accordance with Table A10.1, marking item 18C.

b) For the linear LED lamp operating with a remote LED driver, the LED driver shall be marked in accordance with Table A10.1, marking item 18D.

A6.13.8 A device interchangeable with linear fluorescent lamps shall have a base and overall length of one of the lamp types in Table A6.1.

Table A6.1
Common Linear Fluorescent Lamp Sizes[a]

Lamp diameter in 1/8 inch (mm) / length feet	Common wattage designation	Base Designation	Lamp Length – base face to face inch (mm)
T12 (38 mm)			
2	24	G13	23.2 (590)
3	30	G13	35.2 (895)
4	40	G13	47.2 (1199)
T8 (25 mm)			

Table A6.1 Continued on Next Page

Table A6.1 Continued

Lamp diameter in 1/8 inch (mm) / length feet	Common wattage designation	Base Designation	Lamp Length – base face to face inch (mm)
2	17	G13	23.2 (590)
3	25	G13	35.2 (895)
4	32	G13	47.2 (1199)
5	40	G13	59 (1500)
T5 (16 mm)			
1	8	G5	11.3 (288)
1.5	15	G5	17.2 (437)
2	18	G5	21.6 (549)
T5HO (16 mm)			
2	24	G5	21.6 (549)
3	39	G5	33.4 (849)
4	54	G5	45.2 (1149)
5	80	G5	57 (1449)
Note: Lamp data rounded to 0.1 inch; source: Double Capped Fluorescent Lamps – Dimensional and Electrical Characteristics, NEMA C78.81.			
[a] For additional information, consult Double Capped Fluorescent Lamps – Dimensional and Electrical Characteristics, NEMA C78.81.			

A6.13.9 A device interchangeable with linear fluorescent lamps shall comply with the mass (weight) requirements in A5.4.

A6.13.10 A device described in A6.13 shall be marked, in accordance with A10.1 – A10.4, as appropriate. Type A devices shall additionally comply with the marking requirements in Annex C.

A6.14 Devices interchangeable with tungsten-halogen incandescent lamps

A6.14.1 The requirements in this clause apply to LED devices that have the general appearance, bulb shape, and base types of a conventional T-H incandescent lamp. These devices have the physical dimensions of a lamp described in ANSI C78.24. The following constructions are considered by these requirements:

a) **Type A** – A device for general-use is intended for direct substitution of a TH incandescent lamp, consisting of a MR-11 or M-16 bulb shape and GZ4 or G5.3 base, and operating from a voltage supply less than 30 VAC or 42.4 VDC.

b) **Type B** – A device for general-use is intended for direct substitution of a TH incandescent lamp, consisting of a MR-11 or M-16 bulb shape and GU10 base, and operating from a 120 VAC.

Note: The above type designations are just for use in this Standard.

A6.14.2 A Type A device for general use incorporates the LEDs and control circuitry to limit and or control the LED current. The device is intended to be powered from any LED driver having a suitable voltage and current.

A6.14.3 A component LED lamp for only certain type of LED driver output (such as only Class 2) would not be considered for General-use but could be considered for Special-use applications.

A6.14.4 A component LED lamp intended only for direct current shall comply with the component fault condition tests described in A8.22.

A6.14.5 All devices of this type shall be marked in accordance with A10.1 – A10.4 as appropriate.

A6.15 Linear LED lamps

A6.15.1 Lamps shall comply with the normative application notes defined in the ANSI datasheet for its lamp base, unless more severe requirements exist in this Standard. This includes any ANSI datasheet requirements on mass (weight) limits, input voltage or light source (i.e.: LED).

A6.15.2 Lamps intended for use as components for retrofit luminaire conversions shall additionally comply with the requirements in UL 1598C or CSA C22.2 No. 250.1.

A6.15.3 Lamps that receive power from both ends shall comply with the Risk of Electric Shock – Relamping test, A8.19, unless lamp base contacts are always inaccessible or reliably de-energized when either lamp base is disengaged from its holder.

A6.15.4 When connected to their intended power source in reversed polarity, lamps shall either operate normally, or comply with the LED Lamp and Driver Abnormal Condition Tests, A8.22 in that configuration.

A6.15.5 When a lamp is provided with lamp bases permitted by ANSI for use at more than one voltage, a supply voltage mismatch shall not result in a hazardous lamp operating condition. Compliance is determined by the Voltage Mismatch test – Linear LED Lamps, A8.24.

A6.16 Double insulation

A6.16.1 Double insulated devices shall comply with CSA C22.2 No. 0.1 or UL 2097, and with the requirements outlined in this clause. Devices shall be marked per A10.2.5.

A6.16.2 Reinforced insulation may be employed wherever double insulation is required.

A6.16.3 Creepage and clearance distances separating lamp base contacts operating above 150 V to ground from accessible, ungrounded dead-metal shall be evaluated as reinforced insulation.

A6.16.4 Clearance and creepage distances acting as reinforced insulation shall be at least twice the minimum distances specified by 6.6 and A6.6.

A6.16.5 When conducting any Dielectric voltage-withstand test:

a) Across basic or supplementary insulation, the test potentials specified by CSA C22.2 No. 1993 or UL 1993 shall be used; and

b) Across reinforced insulation, or across double insulation where it is impractical to test the basic insulation and the supplementary insulation separately, twice the test potentials specified by CSA C22.2 No. 1993 or UL 1993 shall be used.

A6.16.6 A single layer of homogeneous material, or a printed circuit board, may be employed as reinforced insulation between conductive parts if the following conditions are met:

a) It is used within the overall equipment enclosure and is not subject to handling or abrasion during device installation, normal use or servicing;

b) There are no sharp points or edges bearing against it; and

c) It complies with the dielectric voltage-withstand test for reinforced insulation.

A6.16.7 In lieu of A6.16.6(b), the Creep test in UL 746C may be used to determine the acceptability of sharp points or edges bearing against insulating materials.

A6.16.8 In the United States, when using UL 2097, Appendix B to determine the minimum required insulation level between different circuits, or between circuits and dead metal, apply Table A6.2.

For Canada and Mexico this clause does not apply.

Table A6.2
Cross-reference of UL 2097 and UL 1993 circuits

UL 2097 Term	UL 1993 Circuit
“PRIMARY”	Any circuit electrically connected to the lamp's supply source (e.g.: circuits not isolated from mains or the external supply circuit).
“HAZARDOUS SECONDARY”	Any Isolated circuit that presents a risk of electric shock during normal operation.
“ELV SECONDARY”	Any Isolated circuit that presents a risk of electric shock only during a single-fault condition.
“SELV SECONDARY”	Any Isolated circuit not considered to present a risk of electric shock under normal operation or any single fault condition (e.g.: Class 2, LVLE, and LPS circuits).
“ENCLOSURE”	Any accessible non-current-carrying conductive (metal) part
Note: This only establishes a level of insulation equivalency, and should not be used to imply that these lamp circuits are SELV or ELV. Circuits cannot be marked “SELV” or “ELV” unless evaluated as such per CSA-C22.2 No. 60950-1 or UL 60950-1.	

A7 Environmental Locations

A7.1 Requirements from 7 apply.

A8 Tests

A8.1 General

A8.1.1 Requirements from 8.1 apply and as amended below.

A8.1.2 The requirements in Section A8 also cover products described in the scope of this Annex.

A8.1.3 Some LED lamps with an ANSI base other than bases E12, E17, E26, E39, or GU24 are intended for connection to a remote LED driver.

Table A8.1
Test plan summary

Test description	Reference	Number and description of samples
Electrical Tests		
Risk of electric shock – relamping	A8.19	1 sample of each lamp.
Isolation of lamp pins	A8.20	1 sample of each construction that can be one sample for a family of products.
Mechanical Tests		
Misapplication of lamp supply connections	A8.21	Not more than four samples; less samples will depend on actual circuit.
LED lamp and driver abnormal condition tests	A8.22	Number of samples depends on complexity of circuitry.
Rigidity after drop test	A8.23	3 or 6 samples; same ones used for Drop and Cold Impact.
LED Lamps – Current Cascade Abnormal	A8.25	1 sample of each representative construction.
Note: This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.		

A8.2 Input measurements

A8.2.1 Requirements from 8.2 apply and as amended below.

A8.2.2 It is permissible to operate an LED lamp in other than a base up position, for this test and the Temperature Test unless it is obvious a certain orientation is intended. See A8.5.2 for additional information.

A8.2.3 LED lamps, with integrated control circuitry, and an ANSI base other than bases E12, E17, E26, E39, or GU10, or GU24 shall be tested with both AC and DC if the lamp rating specifies both current sources.

A8.2.4 For low voltage bases, the device under test is to be powered from a source of AC or DC (as the device is rated) and at the rated voltage or current of the device.

A8.3 Lamp starting and operating measurements

A8.3.1 Requirements from 8.3 do not apply.

A8.4 Leakage-current test

A8.4.1 Requirements from 8.4 apply.

A8.5 Temperature test

A8.5.1 Requirements from 8.5 apply and as amended below.

A8.5.2 A device that is obviously intended only for horizontal mounting. For example, a device for street and parking lot luminaires, and having optical components only in a specific direction is permitted to be tested in a luminaire that fits the application. The luminaire shall represent the smallest volume, or by another method determined to be the luminaire that will result in the most onerous heating.

A8.5.3 Double-ended devices shall be tested in both a horizontal and vertical orientation, or tested only horizontally and marked in accordance with the Table A10.1, marking item 18B.

A8.5.4 Since these requirements cover devices with varied bulb shapes and bases, special fabrication of test boxes beyond the ones described in the main body of this will be necessary. See A9.5.2.

A8.5.6 Double-ended devices shall be subjected to the temperature test of 8.5 while mounted within the test fixture described in A9.5. The temperature on components shall not exceed the limits described in Table 8.2, and no wooden test fixture or lampholder surface shall exceed 90 °C.

A8.6 Dielectric voltage-withstand test

A8.6.1 Requirements from 8.6 apply and as amended below.

A8.6.2 For devices for connection to a low voltage (< 30 V) supply, the test potential shall be 500 V as described in the Dielectric Voltage Withstand Test in UL 8750 or CSA C22.2 No. 250.13.

A8.6.3 For devices other than those in A8.6.2, the test potential shall be equal to 2V + 1000, where V is the maximum working voltage within the device.

A8.7 Harmonic distortion test

A8.7.1 Requirements from 8.7 apply.

A8.8 Drop impact test

A8.8.1 Requirements from 8.8 apply and as amended below.

A8.8.2 All devices for dry, damp, or wet locations and with LEDs shall be subjected to the drop test described in 8.8. The device is not powered during the test, but the assumption is that users might power the device after such an event to see if it is still functioning. Devices with glass or thermoplastic bulbs or lenses shall be additionally assessed as follows:

a) For devices rated for dry or damp locations, there shall be no breakage, cracks, holes or openings in the bulb or lens that permits access to hazardous live parts, as determined by 6.7.

b) For devices rated for wet locations, there shall be no breakage, cracks, holes or openings.

A8.8.3 As an alternative to the drop impact test of A8.8.2, double-ended lamps may be evaluated using the Rigidity after drop test in A8.23.

A8.8.4 With regard to A8.8.2, lamp breakage is acceptable when the damage is so extensive that it is unreasonable to assume an end-user would power the device after the impact, as determined by compliance with this clause. The test results are acceptable if:

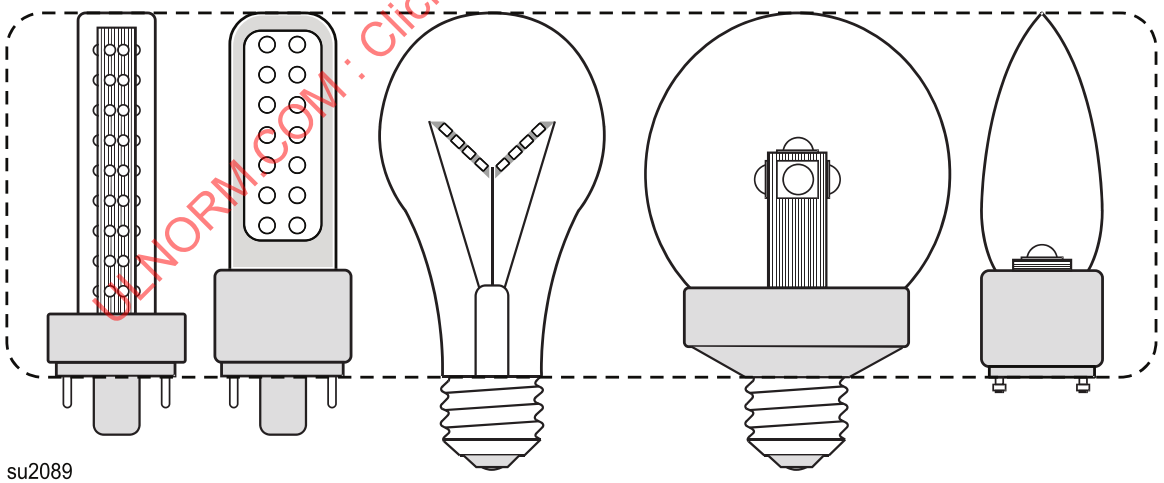
a) Three samples are subjected to the Drop Impact test;

b) At least 50 % of each sample's outer surface area above its base contacts breaks away or becomes permanently separated. The surface area of interest is illustrated by the rectangular dotted box around the lamps in Figure A8.1; and

c) The device packaging is marked per A10.4.3.

Figure A8.1

Outer Surface Area Above Lamp Base Contacts



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A8.9 Mold-stress relief conditioning

A8.9.1 Requirements from 8.9 apply.

A8.10 Deflection test

A8.10.1 Requirements from 8.10 apply.

A8.11 Strain relief test for lamp connectors

A8.11.1 Requirements from 8.12 do not apply.

A8.12 Tests of dimmer circuits

A8.12.1 Requirements from 8.13 apply except as amended below.

A8.12.2 For devices for connection to low voltage (< 30 V) supply, the requirements do not apply.

A8.13 Humidity conditioning

A8.13.1 Requirements from 8.14 apply.

A8.14 Water spray test

A8.14.1 Requirements from 8.15 apply.

A8.15 Cold impact test

A8.15.1 Requirements from 8.16 apply.

A8.16 Lamp fault conditions test

A8.16.1 Requirements from 8.17 do not apply.

A8.17 End-of-lamp-life tests for fluorescent lamp adapters

A8.17.1 Requirements from 8.18 do not apply.

A8.18 End-of-life test for integral, self-ballasted fluorescent lamps – one filament emission-mix-free test

A8.18.1 Requirements from 8.19 do not apply.

A8.19 Risk of electric shock – relamping

A8.19.1 Devices substituting for double-ended or U-bend fluorescent lamps shall be evaluated for a possible risk of electric shock while installing, removing, or replacing the LED lamp device.

NOTE: LED lamps replacing U-bend T8 – T12 fluorescent lamps are included here because, due to the distance between their lamp bases, one base can be seated in a lampholder while the other base is accessible to contact.

A8.19.2 One end (lamp base) of the device under test shall be connected to its intended source of supply while the other end (lamp base) of the device shall be considered accessible and shall be connected to the shock hazard measurement meter circuit and, in turn, to earth ground as shown in Figure A8.2. The test shall be conducted using two methods, in turn, that simulate likely contact scenarios. Each lamp device end (base) shall also be tested in turn. In all cases, the highest measurement shall not exceed 5 M.I.U. RMS:

a) Method A – Contact during insertion into a live circuit. The supply source shall be energized with no lamp in the circuit. One end (base) of the device shall then be connected to the supply source while the other end (base) is connected to the shock hazard measurement meter circuit. Readings shall be monitored for 30 seconds, starting immediately after device connection (insertion). The highest reading shall be recorded.

b) Method B – Contact during removal from a live circuit. The supply source shall be energized with the device in the circuit. One end (base) of the device shall then be disconnected from its lampholder and connected to the shock hazard measurement meter circuit. Readings shall be monitored for 30 seconds, starting at 1 second after disconnection (removal) from the lampholder. The highest reading shall be recorded.

NOTE: A test may be terminated before 30 seconds if non-compliant measurements are recorded.

A8.19.3 The construction of the shock hazard measurement meter circuit, meter, and the explanation of M.I.U. measurement unit are described in UL 935 or CSA C22.2 No. 74. The shock hazard measurement meter circuit is the let-go response network shown in Figure A8.2.

Figure A8.2

Risk of Electric Shock Measurements

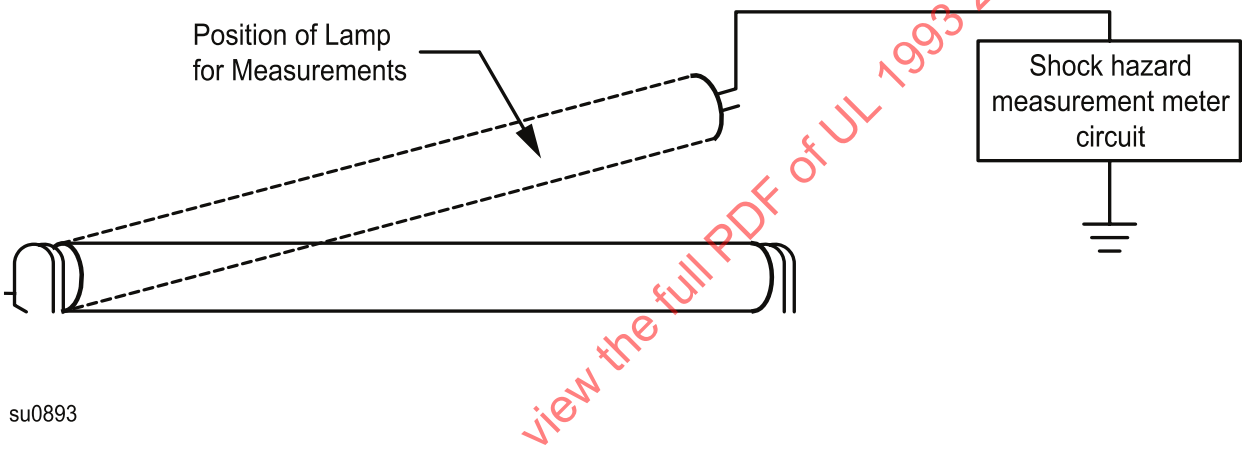

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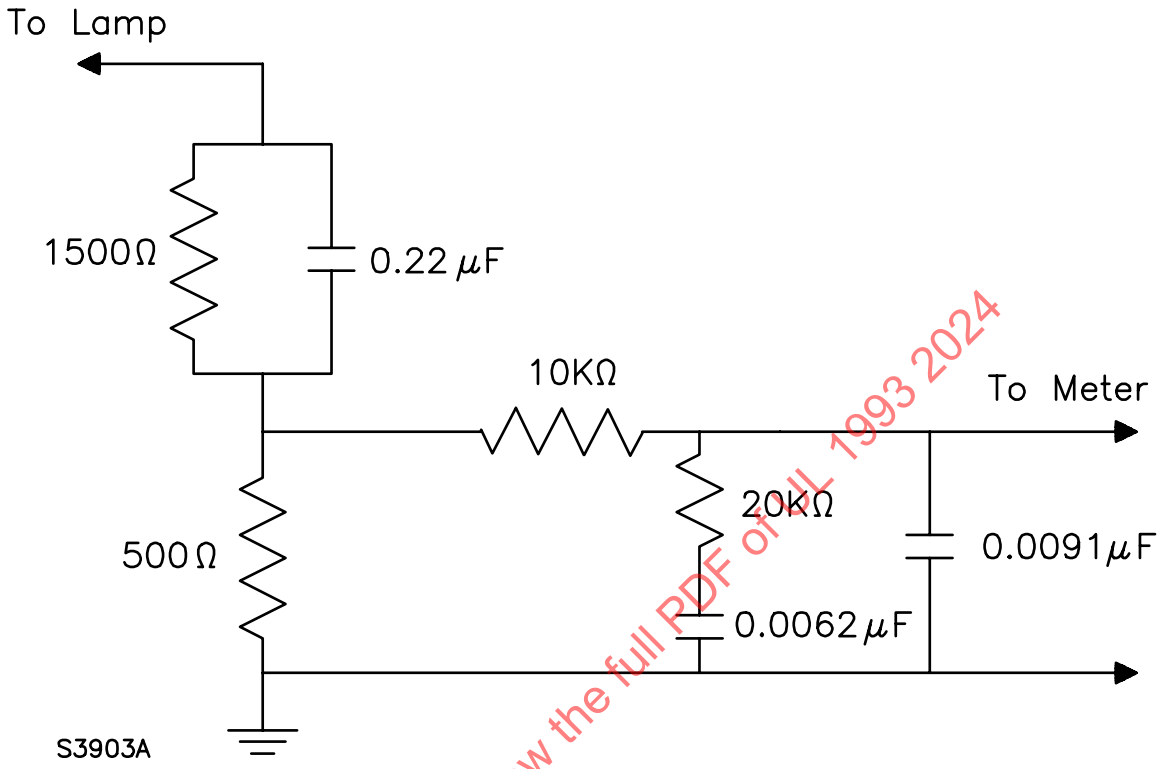
Figure A8.3

Let-Go Response Network



A8.19.4 During the measurement, any externally accessible mechanical interlock mechanism intended to prevent current from flowing through the lamp during its insertion or removal shall be defeated. However, an interlock mechanism located on the free end of the lamp under test is allowed to operate normally if it meets all the following criteria:

a) Actuators shall be located only on the face of the lamp bases and have a normally-open, momentary-type action so that they automatically engage and disengage when the lamp is inserted or removed from the luminaire, respectively;

b) Actuators shall require a force of no more than 4.45 N (1 lbf) to recess completely into the lamp base so that they are flush with the lamp base surface;

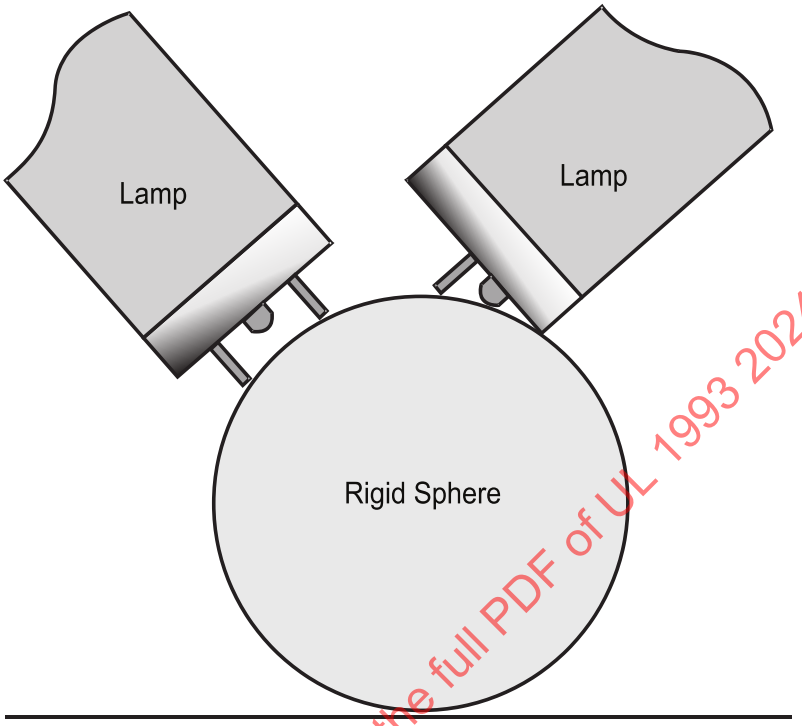
c) The actuator shall be made from or externally encapsulated by an insulating material that complies with the requirements for at least basic insulation;

d) The actuator shall be shaped and located to reduce the likelihood of accidental engagement by an end user during lamp insertion into or removal from an energized luminaire. The actuator is considered to comply with this requirement if it cannot be engaged by a 50.8 mm (2 inch) diameter rigid sphere regardless of how it contacts the lamp, see Figure A8.4; and

e) The interlock mechanism shall endure 500 actuation cycles under its intended electrical load without resulting in mechanical or electrical damage to the lamp or mechanism.

Figure A8.4

Interlock Switch – Accidental Engagement



A8.20 Isolation of lamp pins

A8.20.1 For a device substituting for a linear fluorescent lamp, Type B, and with the intended supply connections only to one lamp base, as described in A6.1.4, the lamp shall withstand the following abnormal operation. The abnormal operation test shall be performed for 7 hours or until the lamp circuit opens. There shall be no visible signs of increased shock or fire hazard.

A8.20.2 The LED lamp shall be operated with 600 V AC applied to the pins of the opposite ends of the lamp for double ended LED lamps.

A8.21 Misapplication of lamp supply connections

A8.21.1 As described in A6.13.5 and A6.13.6, devices substituting for linear fluorescent lamps will have one or more intended, specific connections for electrical supply. Even when the lamp is marked for the intended connections, linear tubular lamps can have a lamp base inserted into an untended lampholder, or rotated clockwise or counterclockwise in the lampholder. Misapplication of the supply voltage can occur either during initial installation for a retrofit luminaire conversion or during a routine lamp replacement.

A8.21.2 For testing of possible misapplications, various lamp positions and supply connections shall be tested. None of the combinations shall result in a fire or shock hazard condition. Opening of a protective component resulting in ceased operation would be an acceptable result.

A8.21.3 For testing of possible misapplications, a grid of lamp connection combinations shall be prepared with the following, as applicable:

a) For the grid columns, the following electrical supply connections:

1) 120 VAC, left lampholder

2) 120 VAC, right lampholder

3) 277 VAC, left lampholder

4) 277 VAC, right lampholder

5) In Canada, 347 VAC, left lampholder

6) In Canada, 347 VAC, right lampholder

7) 120 VAC, left lampholder to right lampholder

8) 24 VDC, at positive at pin 1 of left lampholder

9) 24 VDC, at positive at pin 1 of right lampholder

10) 24 VDC, pin 1 of left lampholder to pin 1 of right lampholder

b) For the grid rows, the following lamp intended connections:

1) 120 VAC rated, connections to one lamp base

2) 277 VAC rated, connections to one lamp base

3) 120 VAC rated, connections to across lamp to each lamp base

4) 277 VAC rated, connections to across lamp to each lamp base

5) In Canada, 347 VAC rated, connections to across lamp to each lamp base

6) DC rated, positive and negative connected at one lamp base, and lamp rotated clockwise in lampholder to seat

7) DC rated, positive and negative connected at one lamp base, and lamp rotated counterclockwise in lampholder to seat

8) DC rated, positive and negative connected across lamp to each lamp base

9) As in case (7) above, but turned to opposite lampholders

The actual device under test will be just one of the grid rows. Depending upon particulars of the device under test, certain conditions can be determined as not applicable (such as testing 24 VDC products at 277 VAC) or additional conditions may be needed.

A8.22 LED lamp and driver abnormal condition tests

A8.22.1 During each test, accessible non-current-carrying metal parts, if provided, shall be connected to ground through a 3-A non-time delay fuse, and the device under test shall be draped with a double layer of cheesecloth conforming to the outline of the unit.

A8.22.2 A risk of fire or electric shock shall be considered to exist with any of the following results:

a) Opening of the ground fuse,

b) Charring of the cheesecloth,

c) Emission of flame or molten material from the unit,

d) Exposure of live parts, or

e) Breakdown during the subsequent dielectric voltage withstand test (described in UL 8750 or CSA C22.2 No. 250.13)

A8.22.3 Lamps may contain integral circuitry to implement communication functions (i.e.: Bluetooth, etc.) or other ancillary features (i.e.: color control or dimming, etc.). Faults to this circuitry and associated functions shall be considered in the abnormal condition tests in A8.22.4 if it is determined that a circuit failure or other malfunction may result in a risk of fire or electric shock, either directly or by disabling a protective device or function.

A8.22.4 Unless previously evaluated, an LED driver shall be subjected to the abnormal condition tests specified in UL 8750 or CSA C22.2 No. 250.13.

A8.22.5 As a separate abnormal test condition, an LED lamp rated only for DC input shall be connected to an AC supply equal to the rated voltage.

A8.23 Rigidity after drop

A8.23.1 Samples shall be prepared by first conducting either the Drop or Cold Impact test, as follows:

a) If conducting the Drop test, three samples shall be used, with each sample dropped once.

b) If conducting the Cold Impact test, six samples shall be used; three after cold conditioning and three unconditioned, with each sample dropped once.

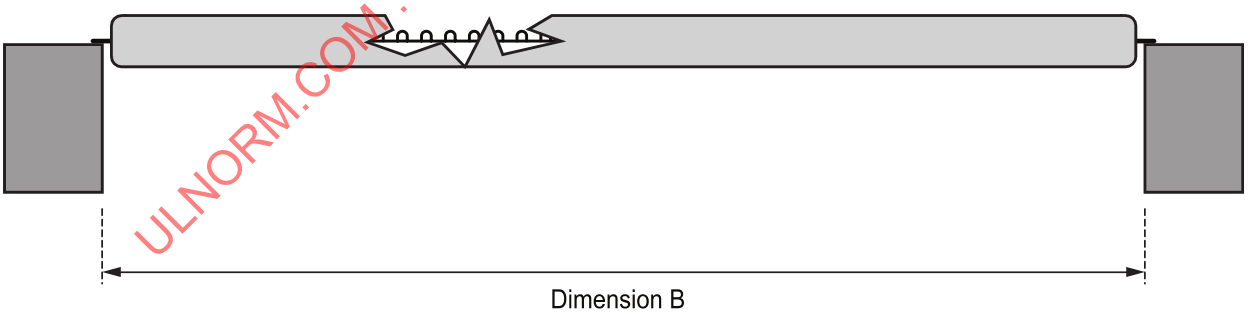
c) After each drop, any parts that dislodge or break off shall be reassembled to the lamp, as long as no tools are needed and the parts can hold themselves in place after reassembly (by friction, snap-fit, etc.).

d) Fluorescent lamp adapters shall be tested without their intended lamp installed.

A8.23.2 After conducting the test described in A8.23.1, each sample in turn shall be carefully placed on a set of rigid cleats, spaced as shown in Figure A8.5, such that the sample is solely supported by its pins in the horizontal orientation that places the least stress on the damaged portion of the lamp.

Figure A8.5

Test Setup – Rigidity After Drop



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A8.23.3 The cleat spacing shall equal the mean of Dimension B, as specified in the ANSI datasheet of the fluorescent lamp that the sample is intended to replace, rounded to the nearest millimeter. See A8.2.

A8.23.4 With respect to A8.23.3, lamps with R17d bases intended to replace fluorescent lamps for which a dimension B is not specified, shall use the mean of dimension C, rounded to the nearest millimeter, minus 8 mm. See Table A8.2.

Table A8.2
Cleat Spacings for Common Linear Fluorescent Lamps

Lamp diameter designation	Nominal lamp length		ANSI Base designation	Cleat spacing	
	m	(ft)		mm	(inch)
T8 or T12	0.61	(2)	G13	596 ±1	(23.47 ±0.04)
	0.91	(3)	G13	900 ±1	(35.43 ±0.04)
	1.2	(4)	G13	1205 ±1	(47.44 ±0.04)
T8 or T12 High Output (HO)	1.2	(4)	R17d	1156 ±1	(45.51 ±0.04)
	1.8	(6)	R17d	1765 ±1	(69.49 ±0.04)
	2.4	(8)	R17d	2375 ±1	(93.50 ±0.04)
T8 or T12 Instant Start (IS)	1.2	(4)	Fa8	1157 ±1	(45.55 ±0.04)
	1.8	(6)	Fa8	1766 ±1	(69.53 ±0.04)
	2.4	(8)	Fa8	2376 ±1	(93.54 ±0.04)
Note: The information in this table is in accordance with NEMA C78.81. For lamp types not tabulated here, consult NEMA C78.81.					

A8.23.5 The results are compliant if all three samples are so damaged that they are unable to remain on the cleats supported only by their pins, and therefore unable to be re-installed and energized within a luminaire.

A8.24 Voltage mismatch test – linear LED lamps

A8.24.1 This test is intended to determine the effect of a voltage mismatch on linear LED lamps. It is conducted under the conditions of the LED lamp and driver abnormal condition tests, A8.22. No test condition shall indicate a risk of fire or electric shock, as defined in A8.22.

A8.24.2 Lamps intended for branch circuit connection shall be connected in turn to each of the line voltage test circuits in Table A8.3 for which they are not rated.

A8.24.3 Lamps intended for low voltage power sources shall be connected in turn to each of the line voltage and low voltage test circuits in Table A8.3 for which they are not rated.

Table A8.3
60 Hz and DC Test Circuits for Voltage Mismatch Test

Line voltage	Low voltage
120 V ac, 20 A capacity	
277 V ac, 20 A capacity [a]	30 V ac, 300 VA capacity
347 V ac, 20 A capacity [b]	60 V dc, 300 VA capacity
[a] In the United States and Mexico	
[b] In Canada	

A8.24.4 With regard to A8.24.3, if ANSI defines a lamp's base for use only on low voltage circuits then testing on line voltage test circuits is waived.

A8.25 LED lamps – current cascade abnormal

A8.25.1 This test applies to devices that employ parts (e.g. LED drivers, LED arrays, etc.) fully sealed within a glass or polymeric envelope (vessel).

A8.25.2 Prior to testing, the highest normal operating current of the LED array shall be determined by energizing the LED lamp at the lamp's rated input voltage that results in the highest array current.

A8.25.3 The sample shall be modified so that the LED array, while sealed within its vessel, can be connected to and powered from a suitable external constant-current supply source.

A8.25.4 Using the setup described in A8.22.1, the sample shall be energized from the external supply source set to the array's highest normal operating current. After 15 minutes, the test current shall be raised by 50 % of its initial value. This step shall be repeated every 15 minutes until the LED device is no longer operable.

A8.25.5 With regard to A8.25.4, if the device's current regulation circuit is also sealed and inaccessible, then the test can be performed by varying the voltage instead.

A8.25.6 At the end of the test there shall be:

a) No rupture of the sealed vessel;

b) No charring of the cheesecloth; and

c) No emission of flame or molten material from the sample.

A9 Test Apparatus

A9.1 General

A9.1.1 Requirements from 9.1 apply.

A9.2 Instrumentation

A9.2.1 Requirements from 9.2 apply.

A9.3 Thermocouples

A9.3.1 Requirements from 9.3 apply.

A9.4 Plywood test box material

A9.4.1 Requirements from 9.4 apply.

A9.5 Temperature test boxes

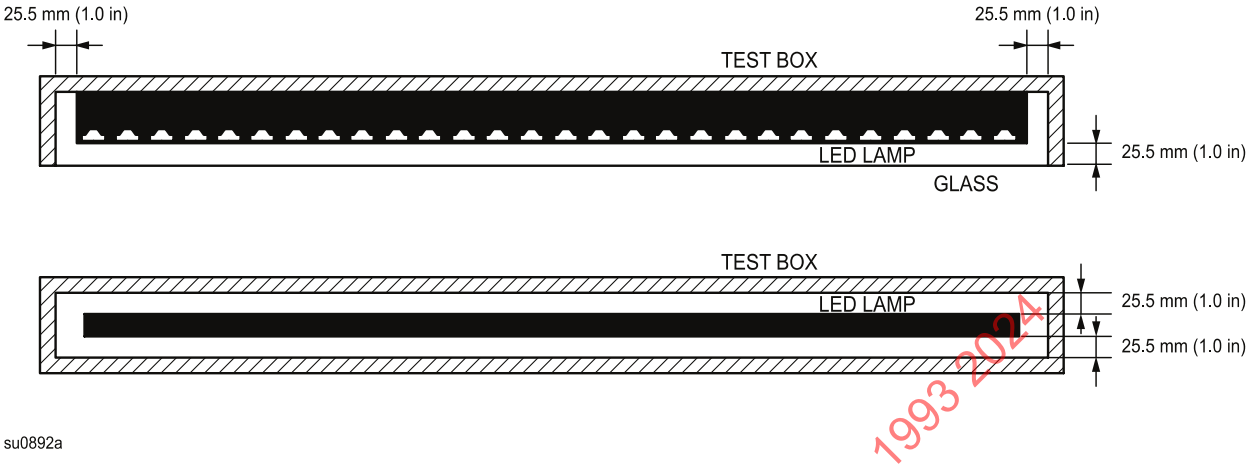
A9.5.1 Requirements from 9.5 apply and as amended below.

A9.5.2 The sides and top of the test fixture shall be constructed of 12.7 mm (1/2 in trade size) thick minimum grade C-D or better plywood. The bottom shall be closed off with a minimum 2.5 mm (0.1 in) thick piece of window glass of appropriate size.

A9.5.3 The test box shall have a square cross-section. The dimensions of the sides of the square shall be equal to the overall LED lamp dimensions plus 25.5 mm (1.0 in). See Figure A9.1 for details.

Figure A9.1

Temperature Test Box



A9.6 Articulated probe

A9.6.1 Requirements from 9.6 apply.

A9.7 Water spray apparatus

A9.7.1 Requirements from 9.7 apply.

A9.8 Cheesecloth

A9.8.1 Requirements from 9.8 apply.

A10 Device Markings

A10.1 General

A10.1.1 Requirements from 10.1 apply.

A10.2 Identifications and ratings

A10.2.1 Requirements from 10.2 apply and as amended below.

A10.2.2 Regarding requirements describing the supply frequency, it would be one of the following and has the following meanings:

a) DC – meaning only direct current,

b) X – Y Hz – meaning “X” is a lower frequency limit or DC, and “Y” is an upper frequency limit.

A10.2.3 In addition to the electrical rating specified in A10.2.2, for

a) Devices substituting for linear fluorescent lamps, Types B and C, connections for the source of electrical supply to the lamp pins shall be clearly marked on the lamp,

b) Devices substituting for linear fluorescent lamps, Type C, the connections for the low voltage supply to the lamp pins shall include polarity, if the supply is a direct current type.

c) Devices interchangeable with tungsten-halogen incandescent lamps, Type A, the connections for the low voltage supply to the lamp pins shall include polarity, if the supply is a direct current type.

A10.2.4 For devices connecting G-type lamp base/holder, the electrical current rating shall not exceed 2 amperes.

A10.2.5 Devices that are double insulated and comply with A6.11.2 shall be marked in accordance with Table A10.1, Item 18A.

A10.2.6 For devices interchangeable with tungsten-halogen incandescent lamps, Types A & B, the device shall be marked, “Only For Dry Locations” or “For Dry Locations,” or the equivalent marking for “damp,” but the full marking Table 10.1, items 9 or 10, shall be provided on packaging or instructions packed with the device.

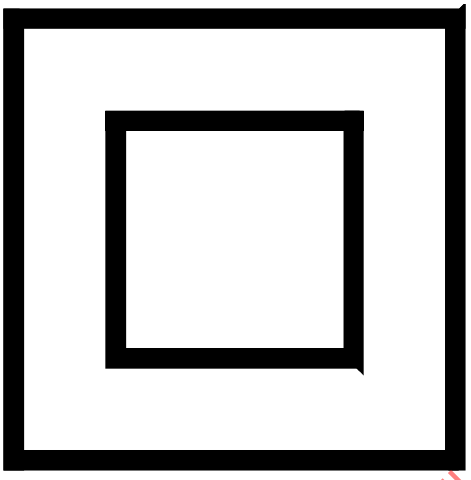
Table A10.1
List of Required Markings

Item	Marking	Text	Format	Text reference
	Product Markings			
18A	**DOUBLE INSULATION (or) DOUBLE INSULATED (or Symbol – a square within a square** (IEC Publication 417, Symbol 5172, as shown in Figure A10.1)	Verbatim, symbol is a graphical element	S13L1	A6.11.2, A10.2.5
18B	**SUITABLE ONLY FOR HORIZONTAL OPERATION (or equivalent words describing the restricted positioning)**	Text or Symbol	S13L1	A8.5.3, A10.2.7
18C	**WARNING – RISK OF FIRE OR ELECTRIC SHOCK. NOT FOR DIRECT REPLACEMENT OF FLUORESCENT LAMPS. USE ONLY WITH (Manufacturer) (Catalog Number) LED DRIVER. SEE INSTRUCTIONS.**		S28-L1	A6.13.7
18D	**REPLACE ONLY WITH (Manufacturer) (Catalog Number) LED Driver.**		S28-L1	A6.13.7
19	**TYPE ___LAMP**	Verbatim	S13-L1	A10.2.8
	Package Markings			
28	**SUITABLE FOR OPEN LUMINAIRES (For devices that would replace TH lamps)**	Verbatim	S13L1	A10.4.2
29	**This lamp employs light emitting diode technology and unlike tungsten-halogen lamps does not require a barrier. Lamp is suitable for open luminaires**		L2	A10.4.2
30	**"TYPE A LAMP - Intended for direct substitution of a fluorescent lamp and operating from the integral ballast without any modifications to the fluorescent luminaire.” or “TYPE B LAMP – Intended for operation in luminaires with traditional fluorescent-type lampholders wired directly to the branch circuit. This includes both factory-wired luminaires as well as those converted for this purpose under a retrofit program.” or “TYPE C LAMP – Intended for operation in luminaires with traditional fluorescent-type lampholders wired to an integral LED driver. This includes both factory-wired luminaires as well as those converted for this purpose under a retrofit program.”**	Verbatim	S28-L2	A10.4.4
31	**CAUTION – RISK OF ELECTRIC SHOCK. Do not use if outer lamp envelope is damaged or broken.**	Verbatim	S28-L2	A10.4.3

Note: The text shown in the table does not represent the actual minimum size and typestyle required. Text in parentheses ( ) is descriptive or informative and not part of the actual marking notice.

Figure A10.1

Double Insulation Symbol



A10.2.7 When a marking in Table A10.1 has a corresponding symbol in Annex F and instructions are included on the packaging explaining the pictogram's meaning, the symbol may be used in place of the corresponding text in Table A10.1.

A10.2.8 For devices substituting for linear fluorescent lamps, the device shall be marked with the appropriate type designation from A6.13.1 in accordance with item 19 in Table A10.1. Devices compliant with the requirements for more than one type shall be marked as such (e.g.: “TYPE A / B LAMP”).

A10.3 Marking requirements in Mexico

A10.3.1 Requirements from 10.3 apply.

A10.4 Instructions

A10.4.1 Requirements from 10.4 apply and as amended below.

A10.4.2 For devices interchangeable with tungsten-halogen incandescent lamps, Types A & B:

a) The packaging shall be marked, “Suitable for open luminaires,” Table A10.1, Item 28. Alternately, additional words can describe the lamp's features, such as “This lamp employs light emitting diode technology and unlike tungsten-halogen lamps does not require a barrier. Lamp is suitable for open luminaires.” See Table A10.1, Item 29.

b) It is permissible to use an alternate wording for Item 22 in Table 10.1 (not for use with emergency fixtures or emergency exit signs), “Not for emergency lighting.”

A10.4.3 For devices compliant with A8.8.3, the smallest unit packaging, point-of-sale package, carton, or instruction sheet packed with the device shall be marked in accordance with Item 30 in Table A10.1.

A10.4.4 For devices substituting for linear fluorescent lamps, lamp type description shall be provided on packaging or instructions packed with the device in accordance with Item 30 in Table A10.1.

ANNEX B
(normative)

Additional Requirements for Solid-State Lamps Containing Silicone Fluid

B1 Special Terminology

B1.1 FLUID – A liquid, oil or gel contained within a lamp or lamp compartment that acts as a dielectric or heat transfer medium. This does not include liquids integral to discrete electrical components, such as the dielectric oil within oil-filled capacitors.

B2 General

B2.1 These construction, test, and marking requirements supplement the requirements in the main body of this Standard.

B2.2 Fluids that undergo a state change (e.g. liquid to gas, liquid to solid) during lamp operation or as a result of lamp breakage or fluid leakage are not addressed by this Annex and may require an additional investigation.

B3 Construction

B3.1 The fluid shall have the following ratings per the NFPA 704 Hazard Identification System:

a) A health hazard rating of 1 or 0;

b) A flammability hazard rating of 1 or 0; and

c) An instability hazard rating of 0.

Lamps containing fluids with a health hazard rating of 1 shall be marked per B5.1.

B3.2 Both the boiling point and the flash point of the fluid shall be at least 50 °C higher than the maximum normal temperature measured on any component or surface in contact with the fluid.

Note: The flash point may be determined using either ASTM D56 or ASTM D93, as applicable to the fluid.

B3.3 The fluid shall not freeze at temperatures warmer than minus 40 °C, at sea level.

B3.4 The dielectric strength of the fluid shall be at least 6.89 kV/mm (175 V/mil), based on the manufacturer's specifications.

B3.5 If the fluid is in contact with a coil device, and if this coil device operates above Class 105 temperature limits, then the fluid and the insulation components of the device shall be evaluated as an insulation system in accordance with UL 1446 or CSA C22.2 No. 0.

B3.6 In reference to B3.5, this does not apply to coil devices that are wholly within a circuit that does not represent a risk of fire or electric shock.

B3.7 The lamp shall not incorporate any pressure-relieving or regulating components that require manual operation or maintenance.

B3.8 If the lamp incorporates an automatic pressure-relieving or regulating component (i.e.: valve, thermostat, etc.):

a) This component shall be disabled or caused to operate in the most deleterious manner allowed by its design during all thermal and abnormal tests; or

b) This component shall be separately evaluated for proper function and reliability in accordance with:

1) UL 60730-1 and UL 60730-2-6; or

2) CSA E60730-1 and E60730-2-6; or

3) NMX-J-591/1-ANCE-2007 and NMX-J-591/2-6-ANCE-2020.

B4 Tests

B4.1 General

B4.1.1 With regard to selecting test orientations for a lamp, consideration shall be given to those that could cause a rapid lamp failure due to sudden overheating as well as those that could cause thermal failure that may take several days to manifest. If it cannot be easily determined which orientation is likely to cause the most severe test result, separate samples shall be tested base up, base horizontal and base down.

B4.1.2 In addition to the other test criteria contained in this Standard, fluid shall not leak or seep from its containment compartment as a result of any test, with the exception of the Drop test.

B4.2 Abnormal operation – partial fluid loss

B4.2.1 Special samples shall be prepared containing only 50 % of the normal volume of fluid. These samples shall be identical to production lamps in every other way.

B4.2.2 The exposed surfaces of the test sample shall be securely wrapped in a double layer of cheesecloth, and then installed in the temperature test box described in 9.5 or A9.5 appropriate for the lamp's size and intended markings. The box shall be oriented to result in the most deleterious lamp operating condition, see B4.1.1. The sample shall then be operated at rated voltage for 7.5 hours or until the sample ceases to function. The sample shall then be subjected to the Dielectric Voltage-Withstand Test in A8.6.

B4.2.3 The test results are considered acceptable if at the end of the test there is no:

a) Charring of the cheesecloth;

b) Emission of flame or molten compound;

c) Leakage or seepage of fluid from its containment compartment;

d) Opening formed that would make live parts accessible; or

e) Breakdown during the subsequent dielectric voltage withstand test.

B4.3 Abnormal Operation – Total Fluid Loss

B4.3.1 Special samples shall be prepared containing no fluid. These samples shall be identical to production lamps in every other way. These shall be tested in accordance with B4.2.2 and B4.2.3.

B5 Markings

B5.1 Lamps containing fluids with a health hazard rating of 1 shall be:

a) Marked "Contains _____, see instructions" in format S13L1. The blank represents the fluid's generic name or designation.

b) Provided with instructions in format S28L2 detailing the lamp manufacturer's recommended cleanup procedure in case of lamp breakage or fluid leakage.

ANNEX C
(normative)

Additional Requirements for LED Lamps and Fluorescent Lamp Adapters Intended as Direct Replacements for Fluorescent Lamps

C1 Special Terminology

C1.1 The following definitions apply:

C1.2 CATHODE CURRENT, RATED – The product of the minimum cathode resistance of the target lamp and the nominal cathode voltage. On NEMA C78.81 data sheets, these are usually found under "Electrical characteristics – Cathode characteristics". This applies only to lamps with cathodes (i.e.: bi-pin and recessed double contact lamps).

C1.3 DC COMPONENT, UNACCEPTABLE – The DC component of a waveform, if it exceeds 1 % of the RMS value of the waveform recorded during Input Measurements. This is determined by monitoring either voltage or current and then calculating the DC component as a percentage of the RMS value.

C1.4 DEVICE – A generic term for an LED lamp or a fluorescent lamp adapter.

C1.5 LAMP ADAPTER, FLUORESCENT – A type of lamp adapter that allows for the replacement of an existing lamp in a fluorescent luminaire with a different, and usually more efficient, fluorescent lamp without making any electrical alterations to the luminaire.

C1.6 LAMP CURRENT, RATED – The rated operating current of the target lamp. On NEMA C78.81 data sheets, this is usually found under “Electrical characteristics – Lamp operating characteristics – Current (A)”.

C1.7 LAMP POWER, RATED – The rated operating power of the target lamp, excluding cathode power. On NEMA C78.81 data sheets, this is usually found under “Electrical characteristics – Lamp operating characteristics – Arc wattage (W)”.

C1.8 TARGET LAMP(S) – The fluorescent lamp or lamps the device is intended to replace.

C2 General

C2.1 The construction, test and marking requirements in Annex C supplement the requirements in the main body of this Standard.

C2.2 These requirements apply to devices intended as direct substitutes for the fluorescent lamps that comply with NEMA C78.81 and NEMA C78.901.

C2.3 These requirements do not apply to devices that, in order to function as intended, require an installer to electrically alter a fluorescent luminaire. Such alterations include removing the ballast or re-wiring the lampholders to bypass the ballast.

C2.4 For the purposes of this Annex, the following assumptions apply:

a) The output of a fluorescent ballast is considered both a risk of fire and risk of electric shock and not isolated from the mains;

b) The device may be installed in open luminaires, without additional enclosures or diffusers; and

c) Double-ended devices will be powered from and supported by the luminaire's existing lampholders, exclusively.

C2.5 The construction and test requirements in the Standard applicable to devices substituting for linear fluorescent lamps shall also apply to LED lamps intended to replace any single-ended fluorescent lamp defined in NEMA C78.901.

C3 Construction

C3.1 The device shall comply with all electrical and mechanical construction requirements in CSA C22.2 No. 1993 and UL 1993 applicable to LED lamps or lamp adapters, as applicable to the device. In addition, the following shall apply:

a) When evaluating electrical spacings between the device's base contacts (pins), and between these points and any exposed dead metal, the required spacings shall be based on the assumed maximum potentials in Table C3.1.

b) With regard to (a), use 6.4 mm (0.25 inch) as the minimum electrical spacing at 1000 volts .

Table C3.1
Assumed Maximum Potentials at Lamp Bases

	Lamps ≤1.2 m (48 in) in nominal length	Lamps >1.2 m (48 in) in nominal length
Between live base contacts (pins)	600 V	1000 V
Between any live base contact (pin) and accessible dead metal	300 V	500 V

C4 Tests

C4.1 General

C4.1.1 Table C4.1 tabulates the test applicable to these devices. All paragraphs referenced below are from UL 1993. See also C4.2.

Table C4.1
Test Plan Summary

Test description	Reference	Number and description of samples[a]
Input measurements[b]	8.2, A8.2, C4.2.2	One sample of device.
Leakage-current[b,c]	8.4	One sample of device; can be the same as used for input measurements.
Temperature[b]	8.5, A8.5	One sample of device. If the device is normally potted, it is 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	8.6, A8.6, C4.2.4	One 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.
Drop impact	8.8, A8.8, C4.2.5	One sample of each enclosure type can be subjected to three drops, or if suitable to all concerned, three samples each of which can be subjected to one drop.

Table C4.1 Continued on Next Page

Table C4.1 Continued

Test description	Reference	Number and description of samples[a]
Mold-stress relief conditioning	8.9	One sample of each enclosure type; may be the same as used in drop test, if undamaged.
Deflection	8.10	One sample of each enclosure type; may be the same as used in drop test, if undamaged.
Humidity conditioning	8.14	For damp location rating, 1 sample; may be used in previous tests.
Water spray	8.15	For wet location rating and the device is not potted, one sample of each enclosure type; can be the same as used in previous tests if intact and undamaged.
Cold impact	8.16, C4.2.5	For wet location rating, three samples of each enclosure type.
Lamp fault conditions[b]	A8.16	Five samples of device; only applicable to fluorescent lamp adapters.
LED lamp and driver abnormal conditions[b, d]	A8.22, C4.2.3	One sample for each component fault, or less if it can be determined that previous faults did not damage the sample. 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.
Rigidity after Drop	A8.23	3 or 6 samples; same ones used for Drop and Cold Impact.
Risk of Shock – Relamping – Type A lamps	C4.5	One sample of each double-ended or U-bend lamp.

[a] This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.

[b] The sample shall be powered from a reference ballast, see C4.1.2 and C4.1.3.

[c] The reference ballast shall be powered from a supply source isolated from both the branch circuit and ground.

[d] Since this device is intended to operate separately from the existing fluorescent ballast, this abnormal test applies to both LED lamps and fluorescent lamp adapters.

C4.1.2 When a test requires the device to be energized from its intended supply source, it shall be energized from both the 60 Hz (line frequency) and high frequency reference ballasts in turn. The reference ballasts shall comply with NEMA C82.3 and be used as the supply sources for the LED lamp tests in this Annex, as follows:

a) The reference ballast shall be initially adjusted for the voltage, current, and power characteristics of the target lamp in accordance with NEMA C82.3. For double-ended fluorescent lamps, these characteristics can be found in NEMA C78.81. For single-ended lamps, these characteristics can be found in NEMA C78.901.

b) With the LED lamp connected and energized from the reference ballast, the input current to the LED lamp and the voltage across the LED lamp are monitored. The reference ballast resistance is then adjusted until one of the following occurs:

1) The LED lamp is operating at the target lamp's rated current; or

2) The voltage across the LED lamp equals the reference ballast input voltage value specified for the target lamp.

c) The high frequency reference ballast shall operate at 50 kHz.

Note: The adjusted power sources are not considered reference ballasts for the purposes of NEMA C78.81.

C4.1.3 As an alternative to the high frequency reference ballast described in C4.1.2, an electronic sinusoidal 50 kHz current source of sufficient current and power capacity may be used to power the LED lamp, provided that the source has the following characteristics:

a) Capacity to supply at least 125 % of the rated input voltage of the target lamp's high frequency reference ballast;

b) Output voltage total harmonic distortion (THD) ≤ 3 % while unloaded;

c) Output frequency regulation ≤ 2 %; and

d) Output current regulation ≤ 1 %.

The current source shall be adjusted to either operating point specified in C4.1.2(b)(1) or C4.1.2(b)(2), whichever occurs first.

C4.1.4 In reference to C4.1.2 and C4.1.3, a device designed and intended to function only on either magnetic or electronic (high frequency) ballasts may be evaluated using only the corresponding 60 Hz or high frequency reference ballast if the device complies with the following when connected to the non-intended reference ballast and tuned for the target lamp it draws no more than 10 % of the target lamp's rated power.

C4.1.5 The electrical characteristics of the device shall be measured in accordance with NEMA C78.375A with the following variations:

a) Lamp seasoning and pre-burning is only required for lamp adapters; and

b) Ambient temperature during testing shall be 25 ±5 °C.

C4.1.6 If the device can be connected to its intended lampholders in more than one configuration, such as what occurs with double ended T8 lamps with G13 bases, the device shall be tested using the wiring configuration that produces the most severe test results.

C4.1.7 With regard to C4.1.6, all possible lamp insertion configurations shall be considered, such as rotating double-ended lamps clockwise or counterclockwise into the lampholder or installing un-keyed single-ended lamps. None of the lamp positions shall result in a risk of fire or shock. Opening of a protective component resulting in ceased operation would be an acceptable result.

C4.1.8 LED lamps replacing target lamps with cathodes shall comply with C4.3, unless compliance with cathode impedance criteria has already been determined as part of the 60 Hz reference ballast measurements.

C4.2 Additional test criteria

C4.2.1 The criteria outlined in C4.2.2 – C4.2.4 are in addition to the requirements of the specified tests.

C4.2.2 When conducting the Input Measurement test, the device:

a) Shall not exceed the rated lamp power or rated cathode current of its target lamp; and

b) Shall not induce an unacceptable DC component on the reference ballast or the cathode transformers. DC component measurements are not required on LED lamps intended only to replace linear T5 fluorescent lamps on electronic ballasts.

If lowering the reference ballast current increases the lamp’s power draw, the test shall be conducted using the current level that produces the highest lamp power.

C4.2.3 When conducting the LED lamp and driver abnormal conditions test, the device:

a) Shall not exceed the rated lamp power or rated cathode current of its target lamp for more than 5 minutes after the application of any fault; and

b) Shall not induce an unacceptable DC component on the reference ballast or the cathode transformers for more than 5 minutes after the application of any fault. DC component measurements are not required on LED lamps intended only to replace linear T5 fluorescent lamps on electronic ballasts.

If lowering the reference ballast current increases the lamp's power draw, the test shall be conducted using the current level that produces the highest lamp power.

C4.2.4 When conducting the Dielectric Voltage-Withstand test between the device's base contacts (pins) and any other part, the test potential shall be based on the assumed maximum voltage to ground at the contacts (pins) specified in C3.1.

C4.2.5 When evaluating the test results of the Drop or Cold Impact tests on double-ended devices , exposure of live parts (for dry and damp location lamps) and cracks (for wet location lamps) is acceptable if all device samples were damaged to the point that they could no longer be supported solely by their base pins. Compliance with this clause shall be determined by conducting the Rigidity After Drop test in C4.3.

C4.3 Cathode measurement

C4.3.1 This measurement is conducted to determine if the resistance across the LED lamp terminals is compatible with that of the target lamp's cathodes ("cathode characteristics"). Each set of lamp pins on the LED lamp are connected to an adjustable AC power source, in turn.

C4.3.2 The AC source is adjusted to the nominal cathode voltage specified in NEMA C78.81 (for double-ended lamps) or NEMA C78.901 (for single-ended lamps). The measured current through the lamp pins is recorded and used to calculate the resistance across the lamp pins.

C4.3.3 As an alternative to C4.3.2 for target lamps with IEC datasheets, the AC source is adjusted to the test current specified in the IEC datasheet. The measured voltage across the lamp pins is recorded and used to calculate the resistance across the lamp pins.

C4.3.4 The test results are considered acceptable if the calculated resistances are no less than the minimum cathode resistance specified on the ANSI or IEC datasheet for the target lamp.

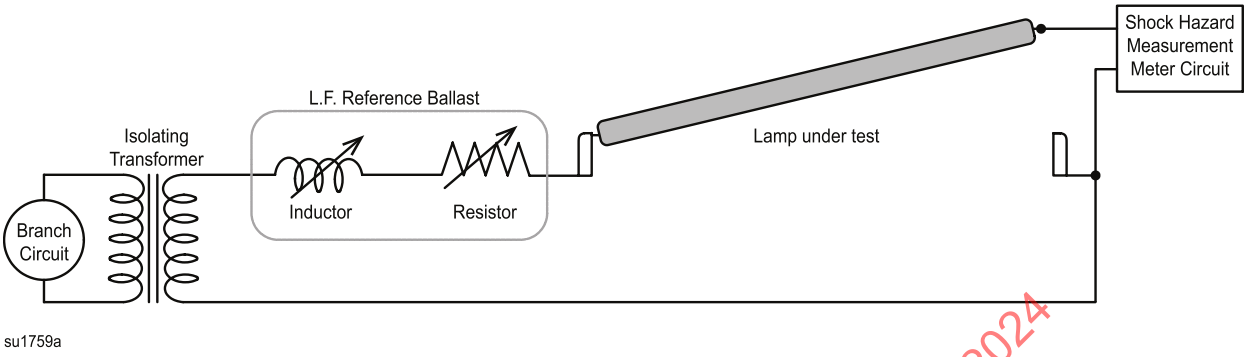
C4.5 Risk of electric shock – Relamping – Type A lamps

C4.5.1 The test described in A8.19 shall be conducted on all devices intended as direct replacements for double-ended or U-bend fluorescent lamps, as modified by this clause. The mechanical interlock requirements in A8.19.4 are applicable to this test.

C4.5.2 When testing direct replacement (e.g.: Type A) lamps, the supply source shall be a 60 Hz reference ballast that is compliant with all pertinent requirements of NEMA C82.3. The reference ballast shall be powered from an isolated supply source. Prior to testing, the reference ballast shall be adjusted for the voltage, current and power characteristics of the target lamp. For double-ended fluorescent lamps, these characteristics can be found in NMX-J-295/2-ANCE-2010, NEMA C78.81 or IEC 60081. Refer to Figure C4.2 for the test setup.

Figure C4.2

Risk of Electric Shock Measurements – Direct Replacement Lamps



C5 Markings and Instructions

C5.1 In addition to the requirements outlined below, the following items of of this Standard are applicable to these devices: Items 1-4 and 8-12, inclusive. Words denoted by brackets may be selected as applicable to the device.

C5.2 A marking shall be provided with the ANSI designation of the target lamp or lamps. See Table C5.1, item 1.

Table C5.1
List of Additional Markings and Instructions

Item	Additional Markings and Instructions	Text	Format	Reference
1	"DIRECT REPLACEMENT FOR _____ LAMPS ONLY" or "DIRECT REPLACEMENT FOR THE FOLLOWING LAMPS ONLY: _____"	Verbatim	S28-L1	C5.2
2a	**"CAUTION – RISK OF FIRE.** USE ONLY IN PLACE OF FLUORESCENT LAMPS SPECIFIED ON LABEL."	Verbatim	S28-L1	C5.3
2b	**"CAUTION – RISK OF FIRE.** USE ONLY IN PLACE OF FLUORESCENT LAMPS SPECIFIED ON LAMP LABEL." **"DO NOT REMOVE THIS LABEL UNTIL READY FOR INSTALLATION."**	Verbatim	L1	C5.3
3	**"CAUTION – RISK OF FIRE.** IF THE [LAMP] [DEVICE] OR LUMINAIRE EXHIBITS UNDESIRABLE OPERATION (BUZZING, FLICKERING, ETC.), IMMEDIATELY TURN OFF POWER, REMOVE [LAMP] [DEVICE] FROM LUMINAIRE AND CONTACT MANUFACTURER."	Verbatim	S28-L2, S28-L1, or both	C5.4
4a	IF INSTALLING THIS [LAMP] [DEVICE] IN A PRE-HEAT LUMINAIRE, REMOVE THE AUTOMATIC STARTERS FROM THEIR HOLDERS BEFORE INSTALLING [LAMP] [DEVICE]		S28-L2, S28-L1, or both	C5.5
4b	IF INSTALLING THIS [LAMP] [DEVICE] IN A PRE-HEAT LUMINAIRE, REPLACE THE AUTOMATIC STARTERS WITH [DEVICE DESCRIPTION] SUPPLIED BY LAMP MANUFACTURER		S28-L2, S28-L1, or both	C5.5
4c	DO NOT INSTALL THIS [LAMP] [DEVICE] IN A PRE-HEAT LUMINAIRE.		S28-L2, S28-L1, or both	C5.5

Table C5.1 Continued on Next Page

Table C5.1 Continued

Item	Additional Markings and Instructions	Text	Format	Reference
5	"THIS [LAMP] [DEVICE] ONLY OPERATES ON [MAGNETIC] [ELECTRONIC] BALLASTS. IF LAMP DOES NOT LIGHT WHEN THE LUMINAIRE IS ENERGIZED, REMOVE [LAMP] [DEVICE] FROM LUMINAIRE AND CONTACT [LAMP] MANUFACTURER OR QUALIFIED ELECTRICIAN."	Verbatim	S28-L2, S28-L1, or both	C5.6
6	EXAMINE LUMINAIRE FOR DAMAGE BEFORE INSTALLING LED LAMP. IF LAMPHOLDERS OR OTHER PARTS ARE VISIBLY DAMAGED CONTACT A SERVICE PERSON.		S28-L2, S28-L1, or both	C5.7
7	DO NOT MIX FLUORESCENT AND LED LAMPS IN THE SAME LUMINAIRE unless Ballast is Marked for this Purpose.		S28-L2, S28-L1, or both	C5.7

C5.3 The device shall be permanently marked to caution users that it is only intended to replace the specific fluorescent lamps that appear on the label. See Table C5.1, item 2a.

Alternatively, this cautionary marking may be conveyed by the text in Table C5.1, item 2b on a field-removable (temporary) adhesive label if:

a) The text is at least 6.4 mm (0.25 inch) tall and printed on a contrasting, opaque background;

b) The label measures at least 150 mm (6 inches) wide and at least 50 mm (2 inches) tall; and

c) The label is secured to the device in such a manner as to block the light from the device if left in place after installation.

C5.4 A cautionary marking or instruction shall be provided instructing users to uninstall the devices if they appear to be causing undesirable operation. See Table C5.1, item 3.

C5.5 If any of the target lamps are pre-heat lamps, or if pre-heat lamps are commercially available with the same nominal diameter, nominal length and base type as one of the target lamps, then a marking or instruction shall be provided to instruct users:

a) To remove the automatic starters from the pre-heat luminaire before installing the device;

b) To replace the automatic starters in the luminaire with the dummy or LED starters supplied by the lamp manufacturer; or

c) Not to use this device in a pre-heat luminaire.

See Table C5.1, items 4a, 4b and 4c.

C5.6 Devices tested per C4.1.2 – C4.1.4 shall be provided with the marking or instruction in Table C5.1, item 5.

C5.7 Devices shall be provided with the markings or instructions in Table C5.1, items 6 and 7, unless ballast is marked for this purpose.

ANNEX D
(normative)

Additional Requirements for LED Lamps Intended as Direct Replacements for High Intensity Discharge (HID) Lamps

D1 Special Terminology

D1.1 The following definitions apply:

D1.2 DEVICE – A generic term for an LED lamp

D1.3 (LAMP) CURRENT LIMIT – The nominal operating current of the target lamp after seasoning, as published by ANSI. On ANSI lamp data sheets, this is usually found under "Operating requirements at 100 hours – Lamp current (A, rms)".

D1.4 (LAMP) POWER LIMIT – The nominal operating power of the target lamp after seasoning, as published by ANSI. On ANSI lamp data sheets, this is usually found under "Operating requirements at 100 hours – Lamp wattage (W)".

D1.5 TARGET LAMP(S) – The HID lamp(s) that the device is intended to replace.

D2 General

D2.1 The construction, test and marking requirements in Annex D supplement the requirements in the main body of this Standard.

D2.2 These requirements apply to devices intended as direct substitutes for one or more HID lamps, such as those defined in NEMA C78.40, NEMA C78.42 and NEMA C78.43.

D2.3 These requirements do not apply to devices that, in order to function as intended, require an installer to electrically alter an HID luminaire. Such alterations include removing the ballast or re-wiring the lampholders to bypass the ballast.

D2.4 For the purposes of this Annex, the following assumptions apply:

a) The output of an HID ballast is considered both a risk of fire and risk of electric shock, and not isolated from the mains;

b) The device may be installed in open luminaires without additional enclosures or diffusers; and

c) Double-ended devices will be powered from and supported by the luminaire's existing lampholders, exclusively.

D3 Construction

D3.1 The device shall comply with all electrical and mechanical construction requirements in this Standard applicable to LED lamps.

D3.2 When evaluating electrical spacings between the device's base contacts, or between any base contact and exposed dead metal, clearance and creepage distances shall comply with this Standard but be no less than those specified by the applicable ANSI lamp base datasheet. These distances shall be at least 3 mm (0.118 inch) for E26 bases and at least 5 mm (0.200 inch) for E39 and EX39 bases.

D3.3 With regard to the weight and moment requirements in 5.4 and A5.4, the maximum moment is not defined for devices with fixed alignments intended for vertical use only and marked per D5.5.

D4 Test

D4.1 General

D4.1.1 Table D4.1 tabulates the test applicable to these devices. All paragraphs referenced below are from UL 1993. See also D4.2.

Table D4.1
Test Plan Summary

Test description	Reference	Number and description of samples[a]
Input measurements[b]	8.2, A8.2, D4.2.2	One sample of device.
Leakage-current[b,c]	8.4	One sample of device; can be the same as used for input measurements.
Temperature[b]	8.5, A8.5	One sample of device. If the device is normally potted, it is 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	8.6, A8.6, D4.2.4	One 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.
Drop impact	8.8, A8.8	One sample of each enclosure type can be subjected to three drops, or if suitable to all concerned, three samples each of which can be subjected to one drop.
Mold-stress relief conditioning	8.9	One sample of each enclosure type; may be the same as used in drop test, if undamaged.
Deflection	8.10	One sample of each enclosure type; may be the same as used in drop test, if undamaged.
Humidity conditioning	8.14	For damp location rating, 1 sample; may be used in previous tests.
Water spray	8.15	For wet location rating and if device is not potted, one sample of each enclosure type; can be the same as used in previous tests if intact and undamaged.
Cold impact	8.16	For wet location rating, three samples of each enclosure type.
LED lamp and driver abnormal conditions[b,d]	A8.22, D4.2.3	One sample for each component fault, or less if it can be determined that previous faults did not damage the sample. 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.
Voltage pulse withstand[b,d]	D4.3	One sample of device.

[a] This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.

[b] The sample shall be powered from a reference ballast, see D4.1.2 and D4.1.3.

[c] For this test, the reference ballast shall be electrically isolated from the branch circuit.

D4.1.2 When a test requires the device to be energized from its intended supply source, it shall be energized from a 60 Hz reference ballast. The reference ballast shall comply with all pertinent requirements of NEMA C82.5.

D4.1.3 The reference ballast shall be adjusted for the voltage, current and power characteristics defined by the lamp standard of the target lamp. See D2.2. Once the LED lamp is connected and energized from the reference ballast, the reference ballast resistance shall be adjusted so that the LED lamp is operating at the target lamp's rated current.