STANDARD FOR SAFETY

UL 8753, Field-Replaceable Light Emitting Diode (LED) Light Engines

Standards Council of Canada
Conseil canadien des normes

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UL Standard for Safety for Field-Replaceable Light Emitting Diode (LED) Light Engines, UL 8753

First Edition, Dated July 31, 2013

Summary of Topics

This revision to UL 8753/ULC-S8753 is being issued to update the title page to reaffirm approval as an American National Standard and as a National Standard of Canada. No changes in requirements have been made.

There are national differences only where standards (U.S. vs. Canadian) are referenced. However, the body of the standard is technically identical for Canada and the U.S.

The requirements are substantially in accordance with Proposal(s) on this subject dated February 16, 2018.

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

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Prepared by:

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Commitment for Amendments

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

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This ANSI/UL Standard for Safety consists of the First Edition including revisions through August 3, 2018.

The most recent designation of ANSI/UL 8753 as a Reaffirmed American National Standard (ANS) occurred on August 3, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), an informative Annex, or the Preface.

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

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Preface

This is the common UL and ULC Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines. It is the First edition of both CAN/ULC-S8753 and ANSI/UL 8753.

This Joint Standard was prepared by Underwriters Laboratories Inc., ULC Standards, and the Technical Committee on Field-Replaceable LED Light Engines. The standard was formally approved by the UL/ULC Technical Committee on Field-Replaceable LED Light Engines. The efforts and support of the Technical Committee are gratefully acknowledged.

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

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

Annex A, Annex B, and Annex C, all identified as normative, form a mandatory part of this Standard.

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

Level of Harmonization

This Standard is published as an identical standard between UL and ULC Standards. An identical standard is a standard that is the same in technical content except for conflicts in Codes and Governmental Regulations. Presentation shall be word for word for editorial changes.

Interpretations

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

1 Scope

1.1 This standard specifies the requirements applicable to field replaceable light-emitting diode (LED) light engines rated up to 347 volts (nominal) and provided with integral lamp bases of other than the screw, bayonet, or pin type configurations typically found on incandescent or fluorescent light sources.

1.2 This standard does not cover:

a) LED devices that are integral components and which form a non-replaceable part of a luminaire, such that they cannot be tested separately from the luminaire;

b) LED lamps or light engines with screw, bayonet or pin-type bases, intended as replacements for incandescent or fluorescent lamps; or

c) LED light engines having a means of supply connection other than the lamp bases allowed by 1.1, such as custom wiring harnesses.

1.3 This standard does not cover the holders, sockets, and the like to which these LED light engines are intended to be mounted. Such products are covered by UL 8754 / ULC-S8754.

2 Reference Publications

2.1 See Annex A for a list of publications referenced in this standard. Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.2 Where any clauses from other standards are referenced in this standard, this is to be interpreted as meaning that all requirements of the referenced clauses apply, except where it is clearly non-applicable to the product being evaluated, or superseded by requirements in this standard.

2.3 Throughout this standard, the CSA and ULC standard references apply to products intended for use in Canada, while the UL standard references apply to products intended for use in the United States. Combined references are commonly separated by a slash (“ / ”).

2.4 For the purposes of this standard, referenced text in the CSA C22.2 No. 1993 / UL 1993, using the word “ballast” is understood to apply to LED drivers, while text using the word “lamp” is understood to apply to LED light engines.

3 Definitions

3.1 The following terms and definitions apply in this standard.

3.2 CIRCUIT, CLASS 2 –

In Canada:

A circuit for which the isolation and electrical output characteristics comply with either CAN/CSA C22.2 No. 223 or both CAN/CSA C22.2 No. 66.1 and the Class 2 requirements in CAN/CSA C22.2 No. 66.3, and that is therefore eligible to be installed as such in accordance with Section 16 of CSA C22.1.

In the United States:

A circuit for which the isolation and electrical output characteristics comply with UL 1310 or the Class 2 requirements in UL 5085-3 and that is therefore eligible to be installed as such in accordance with Article 725 of ANSI/NFPA 70.

3.3 CIRCUIT, ISOLATED LOW VOLTAGE, LIMITED ENERGY (LVLE) – A circuit for which the isolation and electrical output characteristics comply with CAN/CSA-C22.2 No. 250.13 / UL 8750 requirements for LVLE circuits.

3.4 CIRCUIT, LIMITED POWER SOURCE (LPS) – A circuit for which the isolation and electrical output characteristics comply with CAN/CSA-C22.2 No. 60950-1 / UL 60950-1 requirements for LPS circuits.

3.5 DEVICE – A general term for a light engine. A more specific term is used if a requirement applies only to a certain type of device.

3.6 ENCLOSURE – A material or housing provided to enclose parts and components that can involve a risk of fire or electric shock.

3.7 INSULATION, BASIC – The insulation necessary to provide basic protection against the risk of electric shock. This insulation may be in the form of vulcanized fiber, an inorganic or polymeric material, or an air gap.

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

3.9 INSULATION, OPERATIONAL – Insulation that is necessary for the correct operation of the equipment but that is not relied upon for protection against electric shock.

3.10 INSULATION, REINFORCED – A single insulation system with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against the risk of electric shock as does double insulation.

Note: The term "single insulation system" does not necessitate that the insulation must be in one homogeneous piece. The insulation system may comprise two or more layers that cannot be tested as supplementary or basic insulation.

3.11 INSULATION, SUPPLEMENTARY – An independent insulation provided in addition to the basic insulation to provide protection against the risk of electric shock in case of breakdown of the basic insulation.

3.12 LAMP BASE – The part of the device that engages the lampholder and makes contact with the electrical circuits of the lampholder.

3.13 LED ARRAY (LED MODULE) – An assembly of one or more LED packages or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of an LED driver.

3.14 LED DRIVER (CONTROLGEAR) – A component comprised of a power source and control circuitry designed to operate an LED array or module. The control circuitry can range from simple (bridge rectifier and resistor) to complex (incorporating power factor control, constant voltage or constant current outputs, and the like).

3.15 LED LENS, INTEGRAL – The optical element integral to an LED package that redirects 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.

3.16 LED LIGHT ENGINE (LIGHT ENGINE) – An integrated assembly comprised of an LED array (LED module), LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom or industry-standard lamp base. This lamp base shall be of a type not typically found on incandescent or fluorescent light sources.[a]

[a]With permission from ANSI/IES RP-16, Nomenclature and Definitions for Illuminating Engineering, by the Illuminating Engineering Society of North America.

3.17 LED PACKAGE – A discrete assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical and electrical interfaces.

3.18 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. By definition, the grounded (or neutral) mains supply conductor is considered to be a live part.

3.19 LIVE PART, HAZARDOUS – Any live part in which potential can represent a risk of electric shock under any normal or single-fault operating condition. By definition, the grounded (or neutral) mains supply conductor is considered to be a hazardous live part.

3.20 LOCATION, DAMP – An interior or exterior location that is normally or periodically subject to condensation of moisture, including partially protected locations. The interior of a luminaire or sign intended for wet locations is considered a damp location.

Note: 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.

3.21 LOCATION, DRY – A location not normally subject to dampness, but may include a location subject to temporary dampness, as in the case of a building under construction, provided ventilation is adequate to reduce the likelihood of accumulation of moisture.

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

Note: Examples include vehicle washing areas, showers, or unprotected locations exposed to weather.

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

3.24 POLARIZATION (POLARIZED) – A permanent construction feature (e.g., keyed base, rejection pin) that prevents a light engine from engaging its lampholder in more than one electrical configuration (not related to polarization of light).

3.25 SYSTEM, DEFINED-FIT – A group of modular lighting components (e.g., lampholders, light engines, associated mounting and thermal control hardware) defined and evaluated as a unique lighting system for use in luminaires and similar equipment (see 5.5).

3.26 TEST POINT, CASE TEMPERATURE (t_C) – A temperature limit assigned by the manufacturer to a specific location marked on the outer surface of the light engine that is not to be exceeded under normal operating conditions.

3.27 THERMAL INTERFACE – The surface on a light engine intended to make physical contact with a non-integral heat sink, so as to transfer heat away from the light engine. Because of its function, this surface would be inaccessible to contact when the light engine is installed in the end product with its intended lampholder.

3.28 WORKING VOLTAGE – The highest voltage to which an electrical component or insulating barrier could be subjected when the equipment is operating under any condition of normal use.

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 A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the standard(s) appropriate for the country where the product is to be used.

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 Units of measurement

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

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

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

4.3 Assembly and packaging

4.3.1 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.

4.4 Principles

4.4.1 Risk of electric shock

4.4.1.1 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.

4.4.1.2 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.

4.4.1.3 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 CSA C22.2 No. 0 / UL 101.

4.4.1.4 By definition, live parts within the following circuits are not considered to be a risk of electric shock for the purposes of this standard:

a) Class 2 circuits complying with CAN/CSA C22.2 No. 223 / UL 1310,

b) Low-voltage, limited-energy (LVLE) circuits complying with CAN/CSA-C22.2 No. 250.13 / UL 8750, and

c) Limited Power Sources (LPS) complying with CAN/CSA-C22.2 No. 60950-1 / UL 60950-1.

4.4.2 Risk of fire

4.4.2.1 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).

4.4.2.2 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.

4.4.2.3 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 15-VA Available Power Measurement Test (see 8.20), is not considered to be a fire-hazardous circuit.

4.4.2.4 By definition, live parts within the following circuits are not considered to be a risk of fire for the purposes of this standard:

a) Class 2 circuits complying with CAN/CSA C22.2 No. 223 / UL 1310,

b) Low-voltage, limited-energy (LVLE) circuits complying with CAN/CSA-C22.2 No. 250.13 / UL 8750, and

c) Limited Power Sources (LPS) complying with CAN/CSA-C22.2 No. 60950-1 / UL 60950-1.

4.4.2.5 The requirements for enclosures are described in Mechanical Construction, Section 5.

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 1.

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.

5.1.5 Lamp enclosures can be partially or entirely made of glass. The suitability of the glass shall be determined by the mechanical tests outlined in Tests, Section 8.

5.1.6 Housings and compartments containing only Class 2, LPS or LVLE circuits are not required to comply with 5.1.

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 electrical contacts used to engage its intended lampholder are not required to comply.

Exception: Contact is permitted with live parts that are not considered to be a risk of fire.

5.2.2 No openings are permitted on devices designated for wet locations.

5.3 Polymeric materials

5.3.1 A polymeric material used to enclose electrical parts, or used to provide direct or indirect support of live parts, shall comply with the requirements for portable equipment specified in CAN/CSA-C22.2 No. 0.17 / UL 746C, and with the requirements of 5.3.2 – 5.3.10.

Exception: Polymeric materials solely used to enclose an LED array may alternatively comply with the pertinent polymeric requirements in CAN/CSA-C22.2 No. 250.13 / UL 8750.

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 8.4, unless the measured temperature is less than 65°C (149°F).

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 CAN/CSA-C22.2 No. 0.17 / UL 94.

Exception: 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 for this purpose.

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

5.3.5 With respect to CAN/CSA-C22.2 No. 0.17 / 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 polymeric material shall comply with the Mold-Stress Relief Conditioning Test of 8.8.

5.3.7 A polymeric material used for direct support of live parts or as electrical insulation shall have the hot wire ignition (HWI), the comparative tracking index test (CTI), and high current arc ignition (HAI) values tabulated in Table 2.

5.3.8 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 5.3 and is considered basic insulation.

5.3.9 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 CAN/CSA-C22.2 No. 0.17 / UL 746C.

Exception: 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.

5.3.10 Adhesives 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 CAN/CSA-C22.2 No. 250.13 / UL 8750. Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are not subject to this test.

5.4 Mass

5.4.1 The mass of a light engine shall not exceed 200 g.

Exception No. 1: The mass of a light engine that is part of a defined-fit system shall not exceed the mass limit of its system.

Exception No. 2: The mass limit does not apply to a light engine intended for special use applications, where the light engine is used exclusively with a holder that has been evaluated to support it.

5.5 Defined-fit system

5.5.1 Light engines intended for field-replacement shall be part of a defined-fit system. The system's designation shall be marked on the light engine where visible during device replacement (re-lamping). Such devices shall be marked with the system designation and all applicable system identifiers in accordance with Table 7, Item 16.

Exception: Inclusion in a defined-fit system is not required for light engines intended only for special use applications or specific luminaires, as long as they are evaluated with the particular holder, heat sink and associated hardware for which they are intended.

5.5.2 A defined-fit system shall have all of the following characteristics:

a) The system shall be defined in a controlled document or series of controlled documents which shall be publicly available.

b) The document(s) shall identify and define the electrical, mechanical, and thermal specifications for the components in the system.

c) The mechanical and electrical configuration of holders shall be unique to the system and intended to disallow (reject) mating with a non-system light engines.

d) The mechanical and electrical configuration of the light engines shall be unique to the system and intended to disallow (reject) mating with a non-system holders.

e) The system shall define measuring techniques and tolerances for checking dimensional specifications, which may be accomplished using controlled gauges.

f) The system shall allow for field-replacement of light engines by end-users (comparable to the lamp in an incandescent luminaire).

g) The system shall define a unique identifier or set of identifiers (e.g., alphanumeric codes, symbols), that allow end-users to verify that a light engine is electrically, mechanically, and thermally compatible with a particular end-product luminaire during light engine installation or replacement.

6 Electrical Construction

6.1 Light engine bases

6.1.1 Light engines and their bases shall comply with all dimensional specifications applicable to their defined-fit system. Compliance shall be determined by the Dimensional Conformity Tests in 8.21.

Exception: Compliance with a defined-fit system is not required for light engines intended for special use applications only, as long as they comply with the applicable dimensional requirements specified by their manufacturer.

6.1.2 A device's lamp base shall be of a type not typically found on ANSI or IEC-compliant incandescent or fluorescent light sources. For example: Edison-types (e.g., E12, E17, E26), bayonet-types (e.g., BA15, GU10, GU24, GX53) and fluorescent pin types (e.g., G5, G13) shall not be used.

Note: Devices with ANSI or IEC lamp bases may be evaluated to CSA C22.2 No. 1993 / UL 1993.

6.1.3 The lamp base shall be able to withstand the electrical and mechanical stresses particular to field-replaceable light engines. Compliance shall be determined by the following tests: Millivolt Drop in 8.15, Mechanical Cycling in 8.16, and Abnormal Overload in 8.17.

6.1.4 The lamp base contacts shall comply with the material requirements in the UL 8754 / ULC-S8754.

6.2 Current-carrying parts

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

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

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

a) At least one full wrap around a terminal,

b) At least one right angle bend when passed through an eyelet or opening, except on printed-wiring boards where components are properly inserted and soldered or mechanically secured by design, or

c) It is twisted with other conductors.

6.2.4 Iron or steel, plain or plated, shall not be used for current-carrying parts unless it is a part used for the containment of electromagnetic or electrostatic fields.

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

6.3 Printed circuit boards

6.3.1 Printed circuit (wiring) boards shall comply with the applicable requirements in CAN/CSA-C22.2 No. 250.13 / UL 8750 regarding substrate bonding, flame and temperature ratings, and conformal coatings.

6.3.2 Flexible material printed wiring board constructions shall comply with CAN/CSA-C22.2 No. 0.17 / UL 796F.

6.3.3 The suitability of the bonding of the circuit conductors adhered to an alumina ceramic base shall be determined by the following tests specified in UL 796:

a) Foil circuit conductors shall comply with the Bond Strength test.

b) Conductive paste conductors shall comply with the Conductive Paste Adhesion test.

These ceramic materials are not assigned a minimum flame rating.

6.4 Integral LED drivers

6.4.1 LED drivers have outputs that are categorized by CAN/CSA-C22.2 No. 250.13 / UL 8750 as:

a) Class 2 or LVLE circuits,

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

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

6.4.2 The construction of the LED driver circuitry shall comply with the following requirements from CAN/CSA-C22.2 No. 250.13 / UL 8750:

a) Separation of Circuits,

b) Insulating Materials,

c) Circuit Components,

d) Protective Devices,

e) Coil Insulation, and

f) Output Circuits / Class 2 Output Circuits (as applicable).

6.4.3 A fusing resistor shall comply with CAN/CSA-C22.2 No. 60065 / UL 1412; including compliance with the Limited Short Current test using at least a 200A test circuit.

6.4.4 A coil component operating above Class 105 temperature limits shall have an insulation system complying with CSA C22.2 No. 0 / UL 1446.

Exception: Compliance with CSA C22.2 No. 0 / UL 1446 is not required if the failure of any insulation system component cannot result in any of the following:

a) Accessible metal parts becoming live;

b) Hazardous voltages on accessible components; or

c) Loss of isolation between circuits.

6.4.5 The failure of internal electrical components shall not result in a risk of fire or electric shock. Compliance shall be determined by the Abnormal Condition Tests – Light Engine in 8.14.

6.4.6 For light engines intended to operate in contact with a non-integral heat sink, incomplete contact with the heat sink (due to debris or hardware malfunction) shall not result in a risk of fire, electric shock, or degradation of critical insulation or enclosure components to the point where they can no longer perform their intended function. Compliance shall be determined by the Abnormal Temperature Test in 8.19.

6.5 Spacing of electrical parts

6.5.1 Except as noted in 6.5.2 and 6.5.4, the spacing of electrical parts through air (clearance) and over the surface of insulating material (creepage) shall be at least as described in Table 3 for the following:

a) Between uninsulated live parts of opposite polarity;

b) Between live parts operating in different circuits or at different potentials; and

c) Between uninsulated live parts and non-current-carrying metal parts exposed to contact by persons.

For the purpose of determining electrical spacings, an exposed metallic thermal interface, or one covered by only operational insulation, shall be considered a non-current-carrying metal part exposed to contact by persons.

Exception: The electrical spacings between components wholly within a Class 2, LVLE or LPS circuit, or between such components and dead metal, are not defined and such spacings are treated as operational insulation. This exception does not apply to electrical spacings between two or more Class 2, LVLE or LPS circuits (see 6.5.1(b)).

Note 1 Spacings covered by this clause include those between any live PWB component and live parts located elsewhere within the light engine, between any live part and a dead metal enclosure component, and between circuits electrically isolated from one another.

Note 2 Since a metallic thermal interface will be in direct contact with a grounded luminaire component (heat sink) in actual use, at least basic insulation is required between the interface and any live parts within the light engine unless the live parts in question reside wholly within a Class 2, LVLE or LPS circuit.

6.5.2 As an alternative to the spacing requirements in 6.5.1, the clearance and the creepage between conductive parts that are rigidly held in place and reliably spaced in production may be evaluated for compliance with CSA C22.2 No. 0.2 / UL 840. The spacing requirements in CSA C22.2 No. 0.2 / UL 840 shall not be used to determine spacings to an exposed non-current-carrying metal enclosure. Creepage distances shall not be less than clearances.

6.5.3 When applying CSA C22.2 No. 0.2 / UL 840, use the following criteria:

a) Overvoltage Category II for clearances.

b) Pollution degree 3 for conductive parts in wet locations.

c) Pollution degree 2 for conductive parts in dry or damp locations.

d) Pollution degree 1 for conductive parts that are covered with a potting compound or with a conformal coating compliant with the conformal coating test requirements in CAN/CSA-C22.2 No. 0.17 / UL 746C.

6.5.4 The electrical spacings between conductive parts on a printed wiring board may alternatively be evaluated for compliance with UL 8750, and the following:

a) When the power available between two traces within the same circuit is less than 50 W, determined in accordance with the 50-Watt point power measurement test of CAN/CSA-C22.2 No. 250.13 / UL 8750, the spacing between those two parts are not defined.

b) The suitability of the spacing between foil traces may alternatively be determined by conducting a dielectric voltage-withstand test. If there is no dielectric breakdown, then the spacing is considered acceptable. The test potential shall be 2 V + 1000 volts DC for 1 minute, where V equals:

1) The maximum peak potential (in volts) between the traces under any normal operating condition, if both traces are in the same circuit; or

2) The larger of the maximum peak potentials (in volts) of either trace under any normal operating condition, if the traces are in separate circuits.

6.6 Accessibility of live parts

6.6.1 Hazardous live parts shall not be accessible during normal operation or maintenance, or as a result of any mechanical or abnormal test, as determined by 6.6.2 – 6.6.4.

6.6.2 Accessibility shall be determined using the articulate probe of 9.5. When inserted through any opening, the probe shall not contact any hazardous live parts. If operational insulation would prevent such contact, it shall be removed for this determination.

Exception: Not applicable to the electrical contacts of the light engine used to engage its intended lampholder.

Note: By definition, operational insulation is not suitable for protecting against electric shock.

6.6.3 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.

6.6.4 If overcurrent or thermal protective components are integral to the light engine, they shall be inaccessible and non-replaceable.

6.7 LED arrays and modules

6.7.1 The construction of an LED array or LED module shall comply with the following requirements from CAN/CSA-C22.2 No. 250.13 / UL 8750:

a) Separation of Circuits,

b) Insulating Materials,

c) Circuit Components, and

d) Protective Devices.

6.7.2 When the LED array is accessible to the user, it is necessary to determine that at least basic insulation exists in the driver circuitry between the accessible live parts and the source of supply.

6.7.3 An LED array that is inaccessible during normal operation, maintenance and after any mechanical or abnormal test is not prohibited from containing hazardous live parts.

6.7.4 LEDs that emit coherent light shall not be used.

6.7.5 LED arrays and modules used in the construction of the light engine shall not be user replaceable.

6.7.6 LEDs shall not be provided with shunts that would handle the current in the event an open-circuit develops.

6.8 Grounding

6.8.1 Accessible non-current-carrying (dead) metal parts separated from live parts by only basic insulation shall be bonded to ground if the working voltage of the live parts exceeds 150 V to ground.

6.8.2 In lieu of the grounding requirement in 6.8.1, double insulation is permitted. Double insulated devices shall comply with CSA C22.2 No. 0.1 / UL 2097, and be marked per Table 7, Item 14.

6.8.3 When applying CSA C22.2 No. 0.1 / UL 2097, use the following criteria:

a) Reinforced insulation may be used wherever double insulation is required,

b) When a clearance or a creepage distance is acting as reinforced insulation, the required distance shall be twice the value specified by 6.5,

c) When the suitability of a creepage distance acting as reinforced insulation is being determined by the dielectric voltage-withstand test in 6.5.4(b), the test potential shall be twice the specified value; and

d) Basic insulation is considered sufficient between live parts and a metallic thermal interface if no part of the interface is accessible when the lamp is energized, including during insertion into or removal from an energized lampholder, regardless of working voltage.

6.8.4 If a light engine is provided with a contact surface or an electrical contact for grounding accessible non-current-carrying metal parts, then it shall be arranged such that during device installation, the grounding-conductor contact shall engage before the supply contacts. During disconnection, the supply contacts shall disconnect before the grounding-conductor contacts (ground shall be first to make, last to break).

6.8.5 Devices with grounded, accessible dead metal shall comply with the Grounding Contact Test in 8.18.

6.9 Polarization

6.9.1 A loss of polarization, due to an incorrectly-wired lampholder, shall not introduce a risk of electric shock. This shall be determined by the Leakage-Current Test (see 8.3).

6.9.2 Light engines that have lamp bases that are not polarized shall operate normally regardless of how they are connected to their lampholder (see 8.1.8).

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 7, Item 7.

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 use in a damp or wet location.

7.2 Damp locations

7.2.1 A device intended for use in damp locations and marked in accordance with Table 7, Item 8, shall:

a) Comply with the damp location spacing requirements of 6.5, and

b) Comply with the Humidity Conditioning Test in 8.11.

7.3 Wet locations

7.3.1 A device intended for use in wet locations and marked in accordance with Table 7, Item 9 or 10, shall:

a) Comply with the wet location spacing requirements of 6.5,

b) Comply with the UV resistance requirements of 5.3.4, and

e) Comply with the Humidity Conditioning Test in 8.11, Water Spray Test in 8.12, and Cold Drop Test in 8.13.

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 Test Apparatus, Section 9.

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

8.1.4 The tests shall be conducted on samples as specified in Table 4. The test plan summary provides the number and any special preparation of the sample or samples.

8.1.5 All tests shall be conducted with the device connected to a supply circuit of rated voltage and frequency. If the rating includes multiple voltages, or is expressed as a voltage range, then testing shall be conducted at the rated voltage considered to produce the most severe test results.

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. An AC device without a frequency rating shall be tested at 60 Hz.

8.1.7 A light engine shall be operated in the “base up” orientation (LED array shining down), unless it is obvious by design that a certain orientation is intended, or if there is a more severe condition for a particular test.

8.1.8 A light engine with a non-polarized lamp base shall be powered using the wiring configuration that produces the most severe test results.

8.1.9 Unless otherwise noted, testing shall be conducted in an ambient temperature of 25 ±5°C (77 ±9°F).

8.1.10 The supply source used to provide test power to low-voltage light engines during abnormal tests shall have the following characteristics:

a) AC source – A fixed or variable transformer with the capacity to deliver at least 25 A continuously at rated voltage. Its output shall be protected by a 25-A time-delay fuse. Clearing this fuse terminates the test but, by itself, is not considered unacceptable.

b) DC source – An electronic power supply with the capacity to deliver at least 25 A continuously at rated voltage. Its maximum output shall be limited, by impedance or electronic control, to 25 A. Reaching this current limit does not terminate the test and should not shut down the supply source.

8.1.11 If a device is rated for both AC and DC supply sources, it shall be tested on the source likely to produce the more severe test results.

8.2 Input measurements

8.2.1 With the device energized at rated voltage and frequency in accordance with 8.1, the device's input voltage and current shall be measured.

8.2.2 Devices marked with multiple voltage ratings shall be tested at each voltage.

8.2.3 Devices marked with a continuous voltage range shall be tested at both the lower and upper end of the range.

8.2.4 The test results are considered acceptable if:

a) The current measurement does not exceed the marked rating by more than 10%, and

b) If the device is marked with a power rating, the power measurement does not exceed the marked rating by more than 10% plus 0.5 W.

8.3 Leakage-current test

8.3.1 A device with an exposed non-current-carrying metal part shall comply with the leakage current requirements in CAN/CSA-C22.2 No. 250.13 / UL 8750. The measurement shall be made from any accessible non-current-carrying metal part of the enclosure of the device.

8.4 Temperature test

8.4.1 When tested as described in 8.4.2 – 8.4.13, the maximum temperatures shall not exceed those specified in Table 5 when normalized to the case temperature test point rating (t_C). Ambient temperature variations above or below t_C shall be respectively subtracted from or added to temperatures recorded at points on the device in order to make this determination.

8.4.2 A light engine shall be tested in open air while mounted to its intended holder and heat sink. The heat sink's physical and thermal characteristics shall be such that the test simulates the most severe light engine thermal conditions likely to be encountered in service when installed in accordance with its markings.

8.4.3 The normal temperature test shall be conducted with the device oriented and energized in accordance with 8.1.

8.4.4 Light engines shall be provided with a case temperature test point on their exterior surface, designated t_C, which is measured as part of this test and marked per Table 7, Item 15.

8.4.5 The temperature data shall be normalized to the t_C rating to determine compliance with the maximum acceptable temperature limits for the device.

Example: For a t_C marked 80°C (176°F); if the maximum temperature at this point was found to be 73°C (163°F), add 7°C (12.6°F) to all measurements to normalize the data to the rated t_C temperature.

8.4.6 If agreeable to all concerned, the ambient temperature of the entire temperature test setup may be raised until the temperature measured at the t_C point is within 5°C (9°F) of the t_C rating. The temperature data can then be normalized to the t_C rating as described in 8.4.5.

8.4.7 Test point t_C is a manufacturer-declared test point, and may not necessarily be the hottest point on the outer surface of the light engine for the purposes of determining compliance with the enclosure's maximum acceptable temperature limit.

8.4.8 Since these are considered normal operating conditions, circuit-interrupting or power-limiting protective components shall not be triggered by this test. Compliance may be verified by monitoring the device's current or power consumption, or light output.

8.4.9 The test shall be continued until constant temperatures are obtained. Temperatures are considered to be constant if the test has been running for at least 7.5 hours, or:

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 (1.8°F) of one another and are still not rising.

8.4.10 Temperatures shall be measured using thermocouples, which shall comply with 9.3.

8.4.11 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.

8.4.12 When measuring the temperature on the thermal interface, a thermocouple may be cemented within a small hole or depression drilled into the heat sink, provided that the thermocouple bead is located within 1mm of the interface surface.

8.4.13 At the discretion of the manufacturer, the temperature of a coil winding may alternatively be measured by the rise (change) of resistance method in accordance with CAN/CSA-C22.2 No. 250.13 / UL 8750.

8.5 Dielectric voltage-withstand test

8.5.1 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 between all live parts and all accessible non-current-carrying metal parts.

8.5.2 If the enclosure is non-metallic, but is provided with openings into compartments containing electrical parts, then the enclosure shall be tightly wrapped in metal foil, so as to close off all openings. The test shall then be conducted between all live parts and the foil.

8.5.3 The test potential shall be as noted in Table 6, where V is the maximum potential working voltage of the circuits under test.

8.5.4 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.

8.5.5 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.

8.6 Harmonic distortion test

8.6.1 Requirements from CSA C22.2 No. 1993 / UL 1993, Clause 8.7 apply.

8.7 Drop test

8.7.1 All light engines shall be subjected to this test using the test floor described in 9.4. Devices marked for wet locations shall first be conditioned as described in 8.13. After each drop, there shall be no:

a) Damage to the enclosure making uninsulated live parts or internal wiring accessible to contact, as determined by 6.6,

b) Damage to internal components resulting in a reduction of electrical spacings, as determined by a subsequent Dielectric Voltage-Withstand test,

c) Damage that would hinder the ability of the light engine to properly engage its lampholder. The acceptability of any damage as determined by a subsequently performing 10 cycles of the Mechanical Cycling Test (see 8.16), or

d) Damage to wet location light engines that would hinder their ability to resist water ingress, as determined by a subsequent Water Spray Test (see 8.12).

Exception: The tests in (c) and (d) may be waived if, upon close examination, there is no obvious physical damage to the device.

8.7.2 The device shall be dropped three times from a height of 0.91 m (3 ft) so that, in each drop, the device strikes the floor in a position different from those in the other two drops.

Exception: If agreeable to all concerned, three samples may be used with each sample dropped once.

8.7.3 Any damage to a glass enclosure or barrier shall be assessed as if it were polymeric.

8.8 Mold-stress relief conditioning

8.8.1 A completely assembled device having a polymeric enclosure shall be placed in a circulating air oven and maintained at a temperature 10°C (18°F) higher than maximum temperature taken during the Temperature Test of 8.4, but not less than 70°C (158°F) for a period of 7 hours.

8.8.2 The device shall be allowed to cool to room temperature and examined. The device shall not be distorted or have any damage that would impair its usage, and it shall be capable of subsequently withstanding the Dielectric Voltage-Withstand Test of 8.5.

8.9 Deflection test

8.9.1 The enclosure of a lampholder shall be capable of withstanding a force of 89 ±5 N (20 ±1 lbf) applied using a 12 mm (0.472 in) diameter rod with a hemispherical end.

Exception: This test not required if the light engine enclosure components are secured by adhesive or fusion techniques. See 5.3.10 for examples.

8.9.2 The force shall be gradually increased from zero until the specified value is reached and then maintained for a period of 1 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.

8.10 Tests of dimmer circuits

8.10.1 Devices designed for use with a series-connected (two-wire) dimmer, where the dimmer attenuates the supply source of the light engine, shall be tested in accordance with CSA C22.2 No. 1993 / UL 1993, Clause 8.12.

8.10.2 Devices designed for use with a low voltage dimming control, where the dimming signal is received by the device on contacts independent from those used for power, shall be tested as follows:

a) During the Temperature Test in 8.4, the dimming signal shall be adjusted to produce the most severe test results, and

b) The abnormal temperature test in CSA C22.2 No. 1993 / UL 1993, Clause 8.12.3 shall be conducted on the power contacts. During this test, the low voltage dimming signal shall be adjusted to produce the most severe test results.

8.10.3 Devices described in 8.10.2 shall be marked per Table 7, Item 13.

8.11 Humidity conditioning

8.11.1 A device intended for use in damp or wet locations and having accessible non-current-carrying metal parts shall be conditioned for 48 hours in one of the following ambient conditions:

a) 25 ±2°C (77 ±3.6°F), 93 ±5% relative humidity,

b) 28 ±2°C (82 ±3.6°F), 93 ±5% relative humidity, or

c) 32 ±2°C (90 ±3.6°F), 88 ±5% relative humidity.

Following this conditioning and while still exposed to moist air, the device shall comply with the Dielectric Voltage-Withstand Test of 8.5 between current-carrying parts and accessible non-current-carrying metal parts, and be able to operate normally afterwards.

8.11.2 For the purpose of this test an exposed metallic thermal interface, or one covered by only operational insulation, shall be considered an accessible non-current-carrying metal part.

8.12 Water spray test

8.12.1 A device intended for use in wet locations shall be subjected to the test described in 8.12.2. Water shall not enter the ballast or device lampholder compartments.

8.12.2 A device that is marked to indicate a specific orientation or restricted positioning shall be positioned as marked. A device without such a marking shall be positioned in the way that results in the most severe test results. A water spray shall then be applied by the apparatus described in 9.6 for 1 hour.

8.13 Cold drop test

8.13.1 Three samples of devices marked for use in wet locations shall be cooled to a temperature of -35 ±2°C (-31 ±3.6°F) and maintained at this temperature for 3 hours. While still cold, the samples shall be subjected to the Drop Test of 8.7.

8.14 Abnormal condition tests – light engine

8.14.1 A light engine shall be subjected to the Component Failure Test in CAN/CSA-C22.2 No. 250.13 / UL 8750, as amended below.

8.14.2 During each test, any ungrounded accessible non-current-carrying metal parts, if provided, shall also be connected to ground through the 3-A non-time delay fuse.

8.14.3 When the component failure test is performed on a circuit, it may be conducted on any electronic component as either an open or short-circuit.

Exception No. 1: Resistors shall not be short-circuited.

Exception No. 2: Components for which the reliability against failure has been deemed acceptable by a separate investigation. Examples of such components include optical isolators evaluated to CSA Component Acceptance Service No. 5 / UL 1577; and capacitors evaluated to CAN/CSA-E60384-14 / UL 60384-14.

8.14.4 The dielectric voltage withstand test, when necessary, shall be as described in 8.5.

8.15 Millivolt drop test

8.15.1 When tested as described in 8.15.2, the drop in potential across the holder's supply terminals shall not exceed 200 mV at the rated current of the light engine, both before and after the Mechanical Cycling Test in 8.16.

8.15.2 The supply pins of the light engine samples shall be internally shorted together in a manner that does not affect their mechanical engagement with the lampholder contacts (i.e., soldering their fly wires together or soldering a short length of wire across their PWB pads). With the modified light engine fully inserted into its holder, the voltage drop across the holder's supply terminals shall be measured. A DC supply, with its output current limited to within 2% of the light engine's rated current, shall supply the current for this test.

8.16 Mechanical cycling test

8.16.1 Each of the three light engine samples shall be subjected to 500 cycles of insertion and removal from their respective holders (mating sockets) without mechanical malfunction or damage. The holders shall be unpowered for this test.

8.16.2 During each cycle, the sample shall be fully inserted into its holder in a manner that simulates normal use, with the light engine contacts fully engaging the holder's contacts.

8.17 Abnormal overload test

8.17.1 Three samples of the light engines and their holders shall be subjected to the Abnormal Overload test in UL 2459, and as amended below.

8.17.2 The light engine samples shall be prepared by having a suitable load connected across the contact pins within the device so as to cause the device to draw 150% of its rated current at rated voltage. The light engine's electrical circuit may be modified as needed to accomplish this, but care shall be taken not to disturb the ground path, if one is provided.

8.17.3 The samples shall be inserted and removed from their holders to make and break the specified current for fifty cycles of operation, at a rate no greater than 10 cycles per minute.

8.18 Grounding contact test

8.18.1 Three samples of the light engines and their holders shall be subjected to the Grounding Contact – Short-time Withstand Current test in CSA C22.2 No. 2459 / UL 2459, and as amended below.

8.18.2 For each sample, one conductor shall be secured to the holder's ground terminal in the intended manner. The other conductor shall be securely soldered or welded to the accessible non-current-carrying metal parts on the light engine. The conductor size used shall be the largest gauge rated for the holder, but no smaller than 18 AWG.

8.19 Abnormal temperature test

8.19.1 Light engines that are intended to be mounted in contact with a non-integral heat sink shall be subjected to this test, using the setup described in 9.8.

8.19.2 The sample shall be energized and allowed to run for 7.5 hours while monitoring temperatures on the lampholder surface and any polymeric parts on the device serving as enclosure, electrical barrier, or insulation components.

8.19.3 The test results are considered acceptable if:

a) There is no emission of molten material,

b) No point on the cheesecloth chars, ignites, or burns,

c) There are no openings created that permit contact with any part considered a risk of electric shock, as determined by 6.6,

d) The sample complies with the dielectric voltage-withstand test in 8.5 between supply source input and accessible metal parts after this test is complete,

e) No lampholder surface exceeded 90°C (130°F),

f) No polymeric enclosure component exceeded its mechanical impact relative thermal index, and

g) No internal electrical barrier or insulation component exceeded its electrical relative thermal index.

Exception: In lieu of compliance with items f – g, the test may be continued for 15 days or until a protective component permanently shuts down the device, whichever comes first. At the conclusion of the test, if the device complies with items a – e, the results are considered acceptable.

8.19.4 If the test is interrupted by a protective component or feature that automatically resets, the test shall be continued until the component or feature has operated for at least 10 cycles, but not less than 7.5 hours.

8.19.5 If the test is interrupted by a protective component or feature that requires manual reset (e.g., pressing a pushbutton actuator or cycling the supply source off and on), the protector shall be reset and the test restarted. This shall be continued until the component or feature has operated for at least 10 cycles.

8.20 15-VA available power measurement test

8.20.1 When evaluated per 8.20.2 – 8.20.6, 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 1 minute of operation.

8.20.2 The point in the circuit under evaluation is to be connected to the measurement circuit as shown in Figure 1. The external adjustable load resistor is to be initially set for its maximum resistance. The adjustable resistance is then to be reduced gradually to the point where 15VA is being dissipated, and adjusted as needed in an attempt to maintain 15VA for 1 minute. If 15VA cannot be maintained for 1 minute under any load condition, the test shall be discontinued.

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.

Exception: Components for which the reliability against failure has been deemed acceptable by a separate investigation. Examples of such components include optical isolators evaluated to CSA Component Acceptance Service No. 5 / UL 1577; and capacitors evaluated to CAN/CSA-E60384-14 / UL 60384-14.

8.20.4 If a test is disrupted by the operation of a suitable protective component (e.g., fuse, thermal link, fusible resistor) before 1 minute of operation, then that test can be discontinued.

8.20.5 If a test is disrupted by the failure of other circuit components (e.g., capacitor, diode, coil winding, foil trace) 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.

8.20.6 If there is any indication of component overheating during any of the tests described in 8.20.2 – 8.20.5 (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 the Abnormal Condition Tests in 8.14.

8.21 Dimensional conformity tests

8.21.1 For defined-fit systems that require the use of mechanical gauges to verify dimensional conformance, the light engine bases shall comply with all applicable gauges.

8.21.2 Alternatively and where practicable, the critical dimensions of the light engine bases may be measured and compliance verified against the system's specifications.

9 Test Apparatus

9.1 General

9.1.1 This section 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 (68°F to 86°F) 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 W/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 are to 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 ANSI/ISA MC96.1.

9.3.2 It is permissible to use thermocouples consisting of chromel-alumel (Type K) or copper-constantan (Type T) wires if it is determined that high-frequency ballast operation results in eddy current heating of iron and constantan thermocouples.

9.4 Test floor

9.4.1 The test floor used for the drop test 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.

9.5 Articulated probe

9.5.1 See Figure 2 for articulated test probe specifications.

9.6 Water spray apparatus

9.6.1 The water spray test apparatus shall consist of three spray heads constructed in accordance with the details specified in Figure 3 and mounted in a water supply pipe rack as illustrated in Figure 4. 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.

9.7 Cheesecloth

9.7.1 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 centimeter, 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).

9.8 Abnormal temperature test setup

9.8.1 Refer to Figure 5 for an illustration of this setup. This test shall be performed using the same setup and power source that would be used for the Temperature Test in 8.4, as modified below.

9.8.2 The light engine shall be installed in its lampholder with a spacer used to create a gap between the thermal interface and heat sink. This spacer shall be placed as close to the edge of the thermal interface as the construction allows. The spacer shall be a rigid plastic washer, size M5, 10 mm in diameter, 1.0 mm thick (DIN 125).

Exception: If the M5 washer is too thick to allow the light engine to engage and be energized by the lampholder, the next smaller metric washer sizes (M4, M3.5, M3, M2.5, M2 and M1.6) shall be tried in turn. The largest of these washers that allows the light engine to engage and be energized from the lampholder shall be used as the spacer for the test.

9.8.3 A layer of cheesecloth shall be tacked loosely around the sample.

10 Device Markings

10.1 General

10.1.1 A device shall be legibly marked using one or more of the following methods in accordance with Table 7:

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 marking shall be of the minimum size (S____) and in the location (L____) shown in the "Format" column of Table 7 and as defined in Tables 8 and 9.

10.1.3 "Verbatim" in the "Text" column of Table 7 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.

10.1.4 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 C.

10.1.5 All markings shall have lettering in which:

a) The precautionary signal word 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 part of a marking and labeling system in accordance with CSA C22.2 No. 0.15 / UL 969. The adhesive of the pressure-sensitive labels of the permanent type (Type P) shall be suitable for the application surface, temperature, and environment.

10.2 Identifications and ratings

10.2.1 All references are to Table 7 unless otherwise noted.

10.2.2 A device shall be marked with the following:

a) Identification of the company responsible for the product per 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 per Item 2,

c) A date code or other dating period of manufacture not exceeding any three consecutive months per 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, per Item 4.

10.2.3 A device shall be marked with an output rating that includes voltage, frequency, power, and current per Item 5. Devices evaluation for operation over a range of input frequencies shall be marked "X – Y Hz," where "X" is the lower frequency limit, and "Y" is the upper frequency limit.

10.2.4 A device with a power factor rating greater than 0.90 may be marked per Item 6.

10.2.5 With regard to environmental markings:

a) Devices intended for dry locations only shall be marked per Item 7,

b) Devices intended for dry and damp locations shall be marked per Item 8,

c) Devices intended for wet locations without restrictions shall be marked per Item 9, and

d) Devices intended for wet locations with restrictions on their mounting orientation shall be marked per Item 10.

10.2.6 All devices shall be marked per Item 11 unless they have been evaluated for use with dimmers.

10.2.7 Devices evaluated for use on two-wire (e.g, cut-phase) dimmer circuits may optionally be marked per Item 12.

10.2.8 Devices that have been evaluated for use with low voltage dimming controls per 8.10 shall be marked per Item 13. The blank shall be filled with "0 – 10V" or an equivalent descriptor.

10.2.9 Devices that are double insulated and comply with 6.8.2 shall be marked per Item 14.

10.2.10 The case temperature test point rating, t_c, shall be marked per Item 15. The location of this point shall be denoted by a dot, circle, or some other means that allows it to be easily located.

10.2.11 Devices that are part of a defined-fit system shall be marked per Item 16 with regard to their system designation as well as all applicable electrical, mechanical and thermal fit codes (identifiers).

10.3 Instructions

10.3.1 Reserved for future use.

Table 1
Thickness of metal enclosures

Metal	Minimum thickness of metal enclosure, mm (in)	
Die-cast metal	1.2	(0.047)
Uncoated sheet steel	0.66[a]	(0.026)[a]
Nonferrous sheet metal	0.81	(0.032)

[a] 0.51 mm (0.02 in) is acceptable if the enclosed cavity is filled with potting compound.

Table 2
Ratings of polymeric materials[a]

Environmental rating	Minimum Performance Level Class[b,c] (PLC)		
	CTI	HWI[d]	HAI[d]
Dry location	4	4 (3)	3 (2)
Damp location	3	4 (3)	3 (2)
Wet location	2	4 (3)	3 (2)

[a] Enclosures of phenolic, urea, or other thermoset materials are acceptable as legacy materials. Thermoplastic materials shall comply with this table. First, the flammability classification is determined, and then CTI, HWI, and HAI requirements are determined as a function of the flammability classification.

[b] The suitability of materials deficient in one of more performance level may alternatively be determined by the applicable end-product tests or considerations in CAN/CSA-C22.2 No. 0.17 / UL 746C.

[c] 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.

[d] These values assume a V-0 flammability rating. Materials having only 5-VA or 5-VB flammability ratings are acceptable if they comply with the values in parentheses.

Table 3
Minimum spacings at other than printed wiring boards

Location Type	Potential, V[a]	Shortest distance, mm (in)[b]	
Dry or damp	Up to 300 (425)	1.2	(0.046)
Dry or damp	Up to 600 (848)	3.2	(0.125)
Wet	Up to 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.

[b] Intermediate distance values for potentials between 300V and 600V in dry or damp locations may be linearly interpolated.

Table 4
Test plan summary

Test description	Reference	Number and description of samples
Input measurements	8.2	1 sample.
Leakage-current test	8.3	1 sample; can be same as used in the input test.
Temperature test	8.4	1 sample. 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	8.5	1 sample; 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	8.6	1 sample of the device; can be the same as used for input measurements.
Drop test	8.7	1 sample of each enclosure type can be subjected to 3 drops, or if agreeable to all concerned, three samples each of which can be subjected to one drop.
Enclosure mold-stress relief conditioning	8.8	1 sample of each enclosure type; may be same as used in drop test.
Deflection test	8.9	1 sample of each enclosure type; may be same as used in drop test.
Tests with dimmer circuits	8.10	1 sample; may be used in previous tests.
Humidity conditioning test	8.11	For damp location rating, 1 sample; may be used in previous tests.
Water spray test	8.12	For wet location rating and device is not potted, 1 sample of each enclosure type; can be the same as used above.
Cold drop test	8.13	For devices intended for wet locations, three samples of each enclosure type.
Abnormal condition tests – light engine	8.14	Number of samples depends on complexity of circuitry.
Millivolt drop test	8.15	3 samples.
Mechanical cycling test	8.16	3 samples, same as used for millivolt drop.
Abnormal overload test	8.17	3 samples.
Grounding contact test	8.18	3 samples, if provided with grounding means.
Abnormal temperature test	8.19	1 sample; temperature test sample may be used.
15-VA available power measurement test	8.20	Number of samples depends on complexity of circuitry.
Dimensional conformity tests	8.21	Number of samples vary, depending on fit system.
Note: This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.		

Table 5
Maximum acceptable temperature limits

Table 5 revised October 1, 2013

Components	Thermocouple method °C (°F)	Rise of resistance method °C (°F)
Capacitors	[a]	
Fuses	90 (194)	
Coil insulation systems[b]		
Class 105 insulation systems	90 (194)	95 (203)
Class 130 insulation systems	110 (230)	120 (248)
Class 155 insulation systems	135 (275)	140 (284)
Class 180 insulation systems	150 (302)	165 (329)
Potting compound	[c]	
Printed-wiring boards	[a]	
Internal wiring	[a]	
Electrical Insulation		
Vulcanized fiber employed as electrical insulation for other than coil systems	90[d](194[d])	
Other polymeric materials	[a]	
Surfaces		

Table 5 Continued on Next Page

Table 5 Continued

Components	Thermocouple method °C (°F)	Rise of resistance method °C (°F)
Thermal interface	110 (230)	
Any surface that can be contacted by a user during light engine operation or replacement	[e]	
Lampholder surface	90 (194)	
Surface temperature point, t_C	As marked[f]	

[a] For internal polymeric parts, the material's electrical RTI; for electrical components, their marked or rated maximum operating temperature (MOT).

[b] Regarding insulation systems, the maximum acceptable coil temperature shall be the lowest temperature rating of any insulating material or component used in the ballast.

[c] Unless the material is thermosetting, the maximum potting compound temperature, when normalized, shall be at least:

1) 15°C (27°F) less than the softening point of the compound as determined by ASTM E28; or

2) 15°C (27°F) less than the softening point of the compound as determined by ASTM D36/D36M; or

3) 25°C (45°F) less than the softening point of the compound as determined by ASTM D1525.

[d] For vulcanized fiber that has been investigated for use at a higher temperature, the higher temperature applies instead of the maximum temperature.

[e] The lesser of 90°C (194°F) or, if polymeric, the material's relative temperature index (RTI) with impact.

[f] The t_C rating shall not exceed the temperature limitof the surface or the material on which it appears.

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Table 6
Dielectric voltage withstand potential

Test potential (V)	Circuit location
2V + 1000	Between primary circuits and accessible dead conductive parts
	Between secondary circuits operating at greater than 70 V peak, and accessible dead conductive parts
	Between the primary and secondary circuits
	Between PWB traces or other parts operating at different potentials
500	Between a secondary circuit operating at no more than 70 V peak and accessible dead conductive parts
Note: All circuits not electrically isolated from the supply source are considered primary circuits.	

Table 7
List of required markings

Item	Product markings[a]	Text	Format	Text reference
1	**MANUFACTURER'S IDENTIFICATION**		S13L1	10.2.2(a)
2	CATALOG NUMBER or SIMILAR DESIGNATION		S13L1	10.2.2(b)
3	DATE MARKING or CODE FORM		S13L1	10.2.2(c)
4	FACTORY IDENTIFICATION		S13L1	10.2.2(d)
5	____ **VOLTS** ____ **AMPS** _____ **WATTS** ____ **HERTZ** (or) ____ **V** _____ **A** ____ **W** ____ **Hz**		S13L1	10.2.3
6	**HIGH POWER FACTOR or HPF**		S13L1	10.2.4
7	**RISK OF ELECTRIC SHOCK – USE IN DRY LOCATION ONLY**	Verbatim	S13L1	7.1.1, 10.2.5(a)
8	**SUITABLE FOR DAMP LOCATIONS** (or) **RISK OF ELECTRIC SHOCK – DO NOT USE WHERE DIRECTLY EXPOSED TO WATER**	Verbatim	S13L1	7.2.1, 10.2.5(b)
9	**SUITABLE FOR WET LOCATIONS**	Verbatim	S13L1	7.3.1, 10.2.5(c)
10	**SUITABLE FOR WET LOCATIONS – MUST BE USED** (description of restricted positioning)	Verbatim	S13L1	7.3.1, 10.2.5(d)
11	**DO NOT USE WITH DIMMERS**		S13L1	10.2.6
12	**DIMMABLE**		S13L1	10.2.7
13	**USE ONLY WITH ____ DIMMERS**	Verbatim	S13L1	8.10.3, 10.2.8
14	**DOUBLE INSULATION** (or) **DOUBLE INSULATED** (or symbol shown in Figure 6)	Verbatim, or symbol	S13L1	6.8.2, 10.2.9
15	t_C **= xx°C** (xx represents t_C rating)	Verbatim	S13L1	8.4.4, 10.2.10
16	Defined-fit system designation and identifiers (alphanumeric codes or symbols)	Verbatim, or symbol	S13L1	5.5.1, 10.2.11
[a] 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 8
Size designations for marking height, size 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, or Sans Serif
S20	2.0 (0.079)	7.5	
S28	2.8 (0.110)	11	

Table 9
Location designations for markings

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 is not required after installation. It provides installation instruction and information not required after installation. It is made of printed matter with or without attachment to the device.

Figure 1
Connection of wattmeter

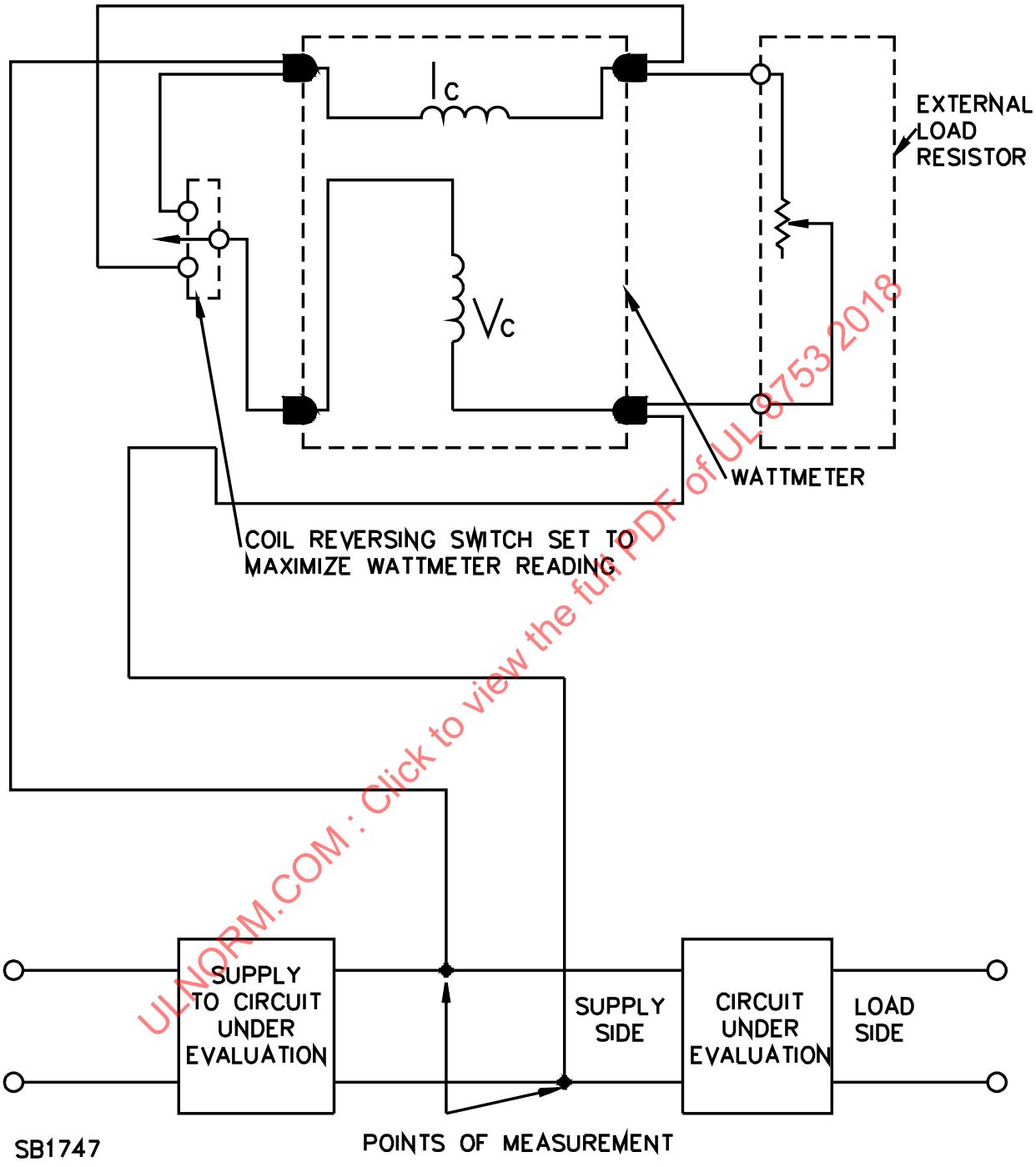


Figure 2
Articulated test probe

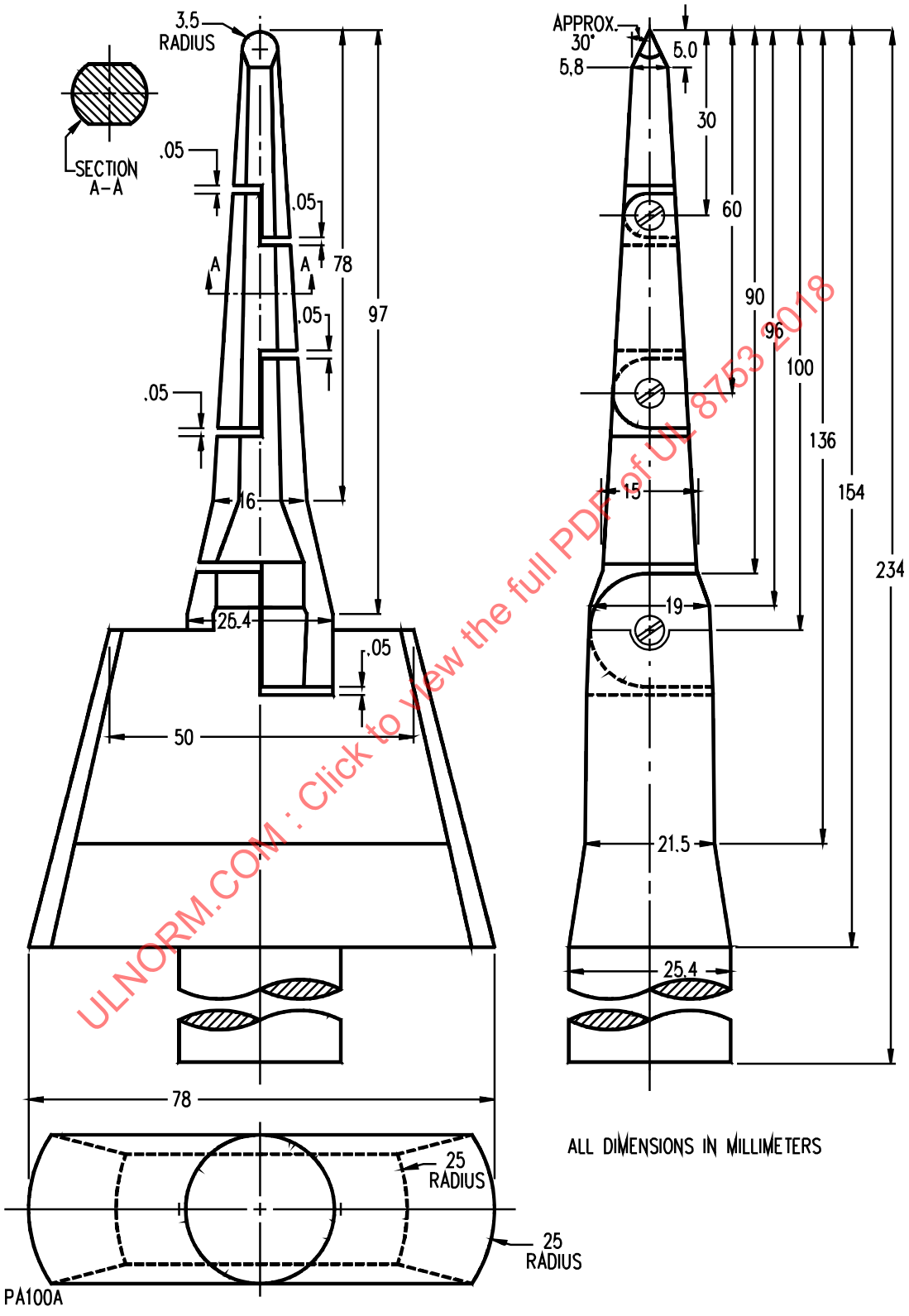
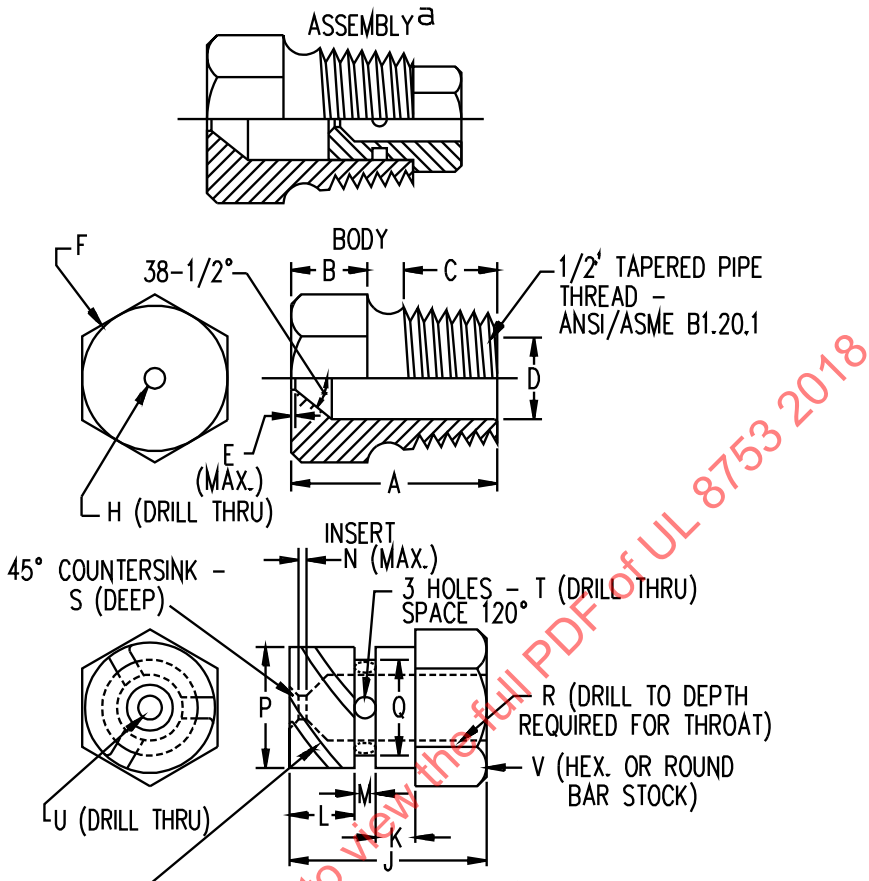


Figure 3
Spray head assembly



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