JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 8802:2023

STANDARD FOR SAFETY

Ultraviolet (UV) Germicidal Equipment and Systems

ANSI/UL 8802-2023

SCC FOREWORD

National Standard of Canada

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UL Standard for Safety for Ultraviolet (UV) Germicidal Equipment and Systems, ANSI/CAN/UL 8802

First Edition, Dated November 16, 2023

Summary of Topics

This is the First Edition of ANSI/CAN/UL 8802, Standard for Ultraviolet (UV) Germicidal Equipment and Systems, dated November 16, 2023.

The requirements are substantially in accordance with Proposal(s) on this subject dated April 28, 2023 and August 25, 2023.

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ANSI/CAN/UL 8802:2023

Standard for Ultraviolet (UV) Germicidal Equipment and Systems

First Edition

November 16, 2023

This ANSI/CAN/UL Safety Standard consists of the First Edition.

The most recent designation of ANSI/UL 8802 as an American National Standard (ANSI) occurred on November 16, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on November 16, 2023.

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Preface

This is the First Edition of ANSI/CAN/UL 8802, Standard for Ultraviolet (UV) Germicidal Equipment and Systems.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 8802 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

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.

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 the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

This edition of the standard has been formally approved by the Technical Committee (TC) on Ultraviolet (UV) Germicidal Equipment and Systems, TC 8802.

This list represents the TC 8802 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

TC 8802 Membership

Name	Representing	Interest Category	Region
Carl Bloomfield	Intertek	Testing & Standards Org.	USA
Juan M. Caamano	UL Solutions	Testing & Standards Org.	USA
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International Classification for Standards (ICS): 91.160.10

This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

INTRODUCTION

1 Scope

1.1 These requirements apply to ultraviolet germicidal irradiation (UVGI) equipment and systems intended for installation and use in accordance with the U.S. National Electrical Code (NEC), NFPA 70 and in accordance with the Canadian Electrical Code, Part I (CEC), CSA C22.1. These requirements cover:

a) UV Germicidal Equipment – These devices emit uncontained UV energy into the surrounding area while the space or room being treated may be occupied. The UV overexposure risk may be mitigated by one or more safeguards. Examples of such safeguards include a fixed installation at a minimum height above the floor, and directional baffling to minimize direct UV emissions towards the occupied space when direct emission is not permitted. This equipment may also produce visible light. See Part 1 of this standard.

b) UV Emitter Assemblies – These devices emit UV uncontained energy into the surrounding area while the space being treated is vacant (i.e., not occupied by persons). Alternatively, these devices can be built into germicidal equipment as components. These assemblies are not considered stand-alone devices; they are intended for use as part of a UV germicidal system. This equipment may also produce visible light. See Part 2 of this standard.

c) UV Germicidal Systems – These systems are intended to expose surfaces within an unoccupied area with uncontained UV energy where the exposure dose would otherwise pose a risk of personal injury to occupants. System components include UV emitters, switches, sensors and other controls acting as site or equipment safeguards. The installation and operating instructions are considered an integral system component. A system may also include devices that produce visible light. See Part 3 of this standard.

d) UV Germicidal Retrofit Kits – These devices are retrofit kits which facilitate replacement of the light source of a General Lighting Service (GLS) luminaire with a UV emitter assembly. These retrofit kits emit UV energy into the surrounding area while the space being treated may be occupied. The UV overexposure risk may be mitigated by the exclusive use of UV sources that are compliant with 'Risk Group 0 (Exempt)' level(s) in accordance with the photobiological assessment for the device. The UV source may also produce visible light. See Part 4 of this standard.

e) Contained UV Germicidal Equipment – These devices include an integral enclosed UV source(s) to treat air flowing through it. The UV overexposure risk may be mitigated through UV source containment by the use of baffles, louvers or similar means to minimize UV emissions from the equipment. This equipment also produces visible light. See Part 5 of this standard.

NOTE – Contained UV Germicidal Equipment that does not produce visible light is generally covered under CSA C22.2 No. 113/UL 507 or CSA C22.2 No. 187/ UL 867.

1.2 Parts 1 through 4 of this standard do not cover:

a) Equipment intended for use in dwellings; or

b) Portable equipment.

NOTE: In regard to item 'a', dwelling refers to the defined term from NFPA 70 and hence does not exclude spaces of transient occupancy where the equipment is expected to be installed and maintained by qualified service personnel.

1.3 This standard does not cover hand-held equipment.

1.4 Products generating ultraviolet radiation are intended for use in accordance with Title 21 Code of Federal Regulations (CFR), Parts 1000 through 1004, and section 1005.25.

NOTE: These regulations include reporting of Accidental Radiation Occurrences, notification to FDA and customers of a radiation safety defect and corresponding plan for corrective action for FDA approval, and designation of a U.S. agent for imported lamps.

1.5 This standard does not apply to UV equipment covered by other (UL or CSA) standards for safety. The equipment not covered by this standard include:

a) Laboratory and health care equipment with UV emitters are covered under the scope of the CSA C22.2 No. 61010 or UL 61010 series of standards; and

b) Horticultural luminaires with UV emitters covered under the scope of UL 8800.

1.6 Equipment that emit electromagnetic energy with wavelengths outside of the 200 – 400 nm range are not fully addressed by this standard, and may require an additional evaluation.

1.7 These requirements address risk of personal injury due to overexposure to UV emissions. To address other safety considerations (e.g., risk of fire or electric shock, or personal injury risks besides UV overexposure) this standard shall be used in conjunction with one of the luminaire standards specified below for devices covered in their respective scopes absent electromagnetic emissions outside of the visible light spectrum. All construction, performance and marking requirements of the standards specified below (see Referenced Publications) shall also apply unless specifically superseded by a requirement in this standard:

a) CSA C22.2 No. 250.0 / UL 1598, for Part 1 – Part 5 devices;

b) CSA C22.2 No. 250.2 / UL 2108, for Part 1 – Part 5 devices; or

c) CSA C22.2 No. 250.4 / UL 153, for Part 5 devices.

1.8 In this standard, the CSA standard reference applies to products intended for use in Canada, while the UL standard reference applies to products intended for use in the United States. Combined references are separated by a slash (“ / ”).

2 Components

2.1 A component of a product covered by this Standard shall:

a) Comply with the requirements for that component as specified in this Standard;

b) Be used in accordance with its rating(s) established for the intended conditions of use; and

c) Be used within its established use limitations or conditions of acceptability.

2.2 A component of a product covered by this Standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product;

b) Is superseded by a requirement in this Standard; or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

2.3 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.

2.4 A component that is also intended to perform other functions such as overcurrent protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

3 Units of Measurement

3.1 The values given in SI (metric) units are normative. Any other values are for information purposes only. See Annex G, Conversion, for metric conversion multipliers.

3.2 Temperatures are given in degrees Celsius only.

3.3 Unless indicated otherwise, all voltage and current values specified in this Standard are root-mean-square (rms).

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements in this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following standards are referenced in this Standard. Portions of these referenced standards may be essential for compliance.

CSA C22.2 No. 14, *Industrial Control Equipment*

CSA C22.2 No. 205, *Signal Equipment*

CSA C22.2 No. 250.0, *Luminaires*

CSA C22.2 No. 250.1, *Retrofit Kits for Luminaire Conversion*

CSA C22.2 No. 250.2, *Lighting Systems*

CSA C22.2 No. 250.4, *Portable luminaires*

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

CSA C22.2 No. 60947-1, *Low-voltage switchgear and controlgear - Part 1: General rules*

CSA C22.2 No. 61010, *Electrical Equipment for Measurement, Control, and Laboratory Use*

CSA C22.2 No. 61058-1, *Switches for Appliances – Part 1: General Requirements*

CSA E61496-1, *Safety of Machinery – Electro-Sensitive Protective Equipment*

CSA C22.2 No. 62471, *Photobiological Safety of Lamps and Lamp Systems*

IEC 60417 (DATABASE), *Graphical Symbols for Use On Equipment*

IEC 62471, *Photobiological Safety of Lamps and Lamp Systems*

IEC 62471-6, *Photobiological safety of lamps and lamp systems – Part 6: Ultraviolet lamp products*

IES RP-27.1, *Recommended Practice for Photobiological Safety for Lamps & Lamp Systems – General Requirements*

IES RP-44, *Recommended Practice: Ultraviolet Germicidal Irradiation (UVGI)*

UL 153, *Portable luminaires*

UL 248-1, *Low Voltage Fuses, and its Series of Standards*

UL 294, *Access Control System Units*

UL 508, *Industrial Control Equipment*

UL 639, *Intrusion-Detection Units*

UL 867, *Electrostatic Air Cleaners*

UL 916, *Energy Management Equipment*

UL 969, *Marking and Labeling Systems*

UL 1598, *Luminaires*

UL 1598C, *Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits*

UL 2108, *Low-voltage Lighting Systems*

UL 8800, *Horticultural Lighting Equipment and Systems*

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

UL 60730-2-9, *Automatic Electrical Controls for Household and Similar Use, Part 2-9: Particular Requirements for Temperature Sensing Controls*

UL 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

UL 61010-1, *Electrical Equipment for Measurement, Control, and Laboratory Use*

UL 61058-1, *Switches for Appliances – Part 1: General Requirements*

UL 61496-1, *Electro-Sensitive Protective Equipment – Part 1: General Requirements and Tests*

ULC S306, *Intrusion-detection Units*

ULC 60839-11-1 , *Alarm and Electronic Security Systems – Part 11-1: Electronic Access Control Systems – System and Components Requirements*

5 Glossary

5.1 For the purpose of this standard, the following definitions apply.

5.2 CONTAINED (CONTAINMENT) – Refers to a design practice where the device's integral UV source is enclosed, louvered, baffled or otherwise protected in order to ensure that UV emissions into the surrounding environment are within the Risk Group 0 (Exempt) limits defined by the referenced photobiological standards. In this standard the terms 'contained' and 'uncontained' identify whether the device utilizes containment as a measure to mitigate UV overexposure.

5.3 CONTAINED GERMICIDAL EQUIPMENT – Equipment with a contained integral UV source to treat air flowing through it. The enclosure may have vent openings to channel air past the UV source for treatment. This equipment also produces visible light.

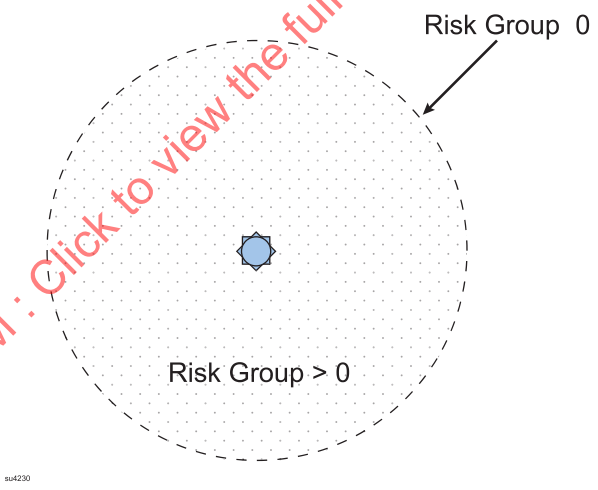
5.4 DEVICE – Unless otherwise specified, this is a generic term for any UV equipment or component.

5.5 EMITTER – A device component that produces UV radiation.

5.6 EXEMPT PERIMETER – The boundary around a single device formed by the line-of-sight distance from its geometric center to points where UV emissions are considered Risk Group 0 (Exempt). These points are drawn on the horizontal plane formed by the floor. See Figure 5.1 for a graphical representation of this perimeter.

Figure 5.1

Graphical Representation of Exempt Perimeter



NOTES:

1. This boundary is declared by the manufacturer and verified by test. By definition, persons standing at the edge of this boundary do not require additional safeguards against UV overexposure, as defined by IEC 62471, CSA-C22.2 No. 62471, or IES RP-27.1, when the emitter is operating.

2. This figure is for reference purposes only. The perimeter's shape will depend on device design and may not be circular or symmetrical. In addition, when the line-of-sight distances for actinic and near UV are different, the larger of the two values are used to determine the exempt perimeter.

5.7 GENERAL USE DISTANCE – For equipment marked with a minimum mounting height, this is the shortest vertical distance between the lowest point of emissive surface on the device when mounted at this minimum marked height and the measurement plane above and parallel to the finished floor.

NOTE: Examples of general use distance are illustrated in Figure 8.1 of Part 1.

5.8 INSTRUCTED OPERATOR – An individual charged to operate the equipment or system who has been provided with adequate training to operate the system, but may need to call on a qualified service person when the system is not operational or safe shutdown has occurred.

5.9 INTERLOCK – A mechanism designed to automatically open an electrical circuit in order to prevent a risk to a user by disabling the source posing a hazard (e.g.: the UV source of Contained UV Germicidal Equipment). The interlock may close the circuit once the user is no longer exposed to the risk. An interlock can consist of one or more switches, actuators, guards, and associated circuitry and hardware.

5.10 OCCUPANT – Individual(s) who may be present in the treated space where emitters are installed. It is assumed that occupants may not be aware of presence of the UV germicidal equipment or system and cannot be expected to take any precautions against UV exposure while the equipment or system is operating.

5.11 OCCUPIED SPACE – The volume in a treated space below the measurement plane.

NOTE: Examples of occupied space are illustrated in Figure 8.1 of Part 1.

5.12 ORDINARY TOOLS –– Tools that can normally be expected to be available to the user, such as screwdrivers, hammers, nut drivers, pliers. Any tools designed to adjust hardware with flat, hex, Philips, square or Robertson configurations are considered ordinary tools for the purpose of this standard.

5.13 PORTABLE EQUIPMENT – Cord-connected electrically operated equipment capable of being easily moved by hand from place to place. Portable equipment may be floor or counter supported in normal use. In this Standard, portable equipment is considered unattended and stationary while operating during normal use.

NOTE: In this standard, the term “portable equipment” represents a smaller set of products than those covered by CSA C22.2 No. 250.4 and UL 153. Hand-held luminaires are excluded from the scope of UL 8802.

5.14 QUALIFIED SERVICE PERSON – An individual charged to repair the UV germicidal equipment or system. They may also manage the routine maintenance of the equipment or system.

5.15 SAFE SHUTDOWN – A safe state where a device ceases to operate due to an abnormal operating condition (for example, a fault), and one that requires the intervention of an instructed operator or qualified service person in order to restore normal equipment operation. UV germicidal equipment and systems should not pose a risk of UV overexposure to occupants after a safe shutdown.

5.16 SAFEGUARD, EQUIPMENT – Safeguards that are part of the UV germicidal system. These can be integral to or remotely mounted from the device.

5.17 SAFEGUARD, SITE – Controls installed near or within the treated space that reduce the likelihood of occupancy immediately before or during emitter operation. Examples include interlocks on entry doors, as well as arming switches located within the treated space.

5.18 SAFEGUARDS – In the context of this standard, controls that function to prevent or reduce the likelihood of personal injury due to overexposure to UV energy.

5.19 TREATED SPACE – The area that is exposed to UV energy when an emitter is in operation.

5.20 ULTRAVIOLET (UV) EMITTER ASSEMBLY – Devices intended to emit UV energy into the treated space while the space is vacant (i.e.: not occupied by people). These are not considered stand-alone devices; these devices are intended for use as part of a UV germicidal system.

5.21 ULTRAVIOLET (UV) GERMICIDAL EQUIPMENT – Equipment intended to emit uncontained UV energy into the treated space while this space is occupied (or in use) by people.

NOTE: These devices may also be referred to as “upper-room luminaires”, “UV Germicidal Irradiators (UVGIs)”, or Germicidal Ultraviolet (GUV) luminaires.

5.22 ULTRAVIOLET (UV) GERMICIDAL RETROFIT KIT – A retrofit kit that replaces the light source of a General Lighting Service (GLS) luminaire with a UV emitter assembly. The UV emitter assembly shall be classified as ‘Risk Group 0 (Exempt)’ when evaluated for Photobiological Assessment. The UV emitter may also produce visible light. A UV retrofit kit includes all component parts required, including instructions, for conversion of a GLS luminaire to a UV emitter assembly.

5.23 ULTRAVIOLET (UV) GERMICIDAL SYSTEM – A system utilizing uncontained UV emitters that is intended to operate only when the treated space is vacant (i.e.: No occupants in the treated space during its operating cycle).

5.24 ULTRAVIOLET (UV) RADIATION – Electromagnetic energy with a wavelength of 200 – 400 nm.

5.25 ULTRAVIOLET (UV) SOURCE – The UV emitting optical element or surface. In particular, the outermost emitting surface of the final optic-altering entity such as the outer surface of an emitter or the outer surface of a protective, diffusing or beam shaping lens of a lamp or luminaire.

6 Organization and Application

6.1 This Standard is organized as follows:

a) Part 1 – UV Germicidal Equipment;

b) Part 2 – UV Emitter Assemblies;

c) Part 3 – UV Germicidal Systems;

d) Part 4 – UV Germicidal Retrofit Kits; and

e) Part 5 – Contained UV Germicidal Equipment

PART 1 – UV GERMICIDAL EQUIPMENT

7 General

7.1 Germicidal equipment shall comply with one of the applicable safety standards in 1.7 in addition to the requirements in Part 1 of this Standard.

7.2 Devices that use low-pressure discharge lamps shall comply with the requirements applicable to fluorescent luminaires.

7.3 Devices shall be designed to be permanently mounted in a fixed location, such that it cannot be unmounted or relocated without the use of tools.

7.4 Devices not intended to be adjusted by the end-user shall be designed such that it is not possible to re-orient or refocus the UV source using ordinary tools.

8 Photobiological Assessment

8.1 Equipment shall not pose a risk of personal injury to persons due to UV overexposure when installed, tested and operated in accordance with the manufacturer's instructions and the requirements of this Standard.

8.2 In order to determine compliance with 8.1, the device shall be subjected to a photobiological assessment for actinic and near UV hazards from 200 nm through 400 nm in accordance with the requirements in CSA C22.2 No. 62471 (in Canada) or IEC 62471 (in the United States). This assessment shall be used to determine the risk group of the device for these hazards. The measurement distance from the UV source to the measuring instrument shall be as specified in 8.6 to 8.10.

8.3 At the manufacturer's request, the photobiological assessment in 8.2 may alternatively be conducted in accordance with IES RP-27.1 for actinic and near UV hazards from 200 nm through 400 nm, with the exception that the measurement distance from the UV source to the measuring instrument shall be as specified in 8.6 to 8.10. This assessment shall be used to determine the risk group of the device for these hazards.

8.4 When the equipment employs multiple UV sources, all sources must be simultaneously energized during the measurement in 8.2 unless an integral control regulates the selection or timing of the UV sources. Such an integral control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

8.5 The measurement instrument shall have a sensor with an aperture limiting the detector field of view cone in accordance with IEC 62471-6 or IES RP-27.1, as applicable. The centerline of the sensor aperture, normal to the surface area of the detector, shall be oriented to result in the highest reading at that point from the UV emission source.

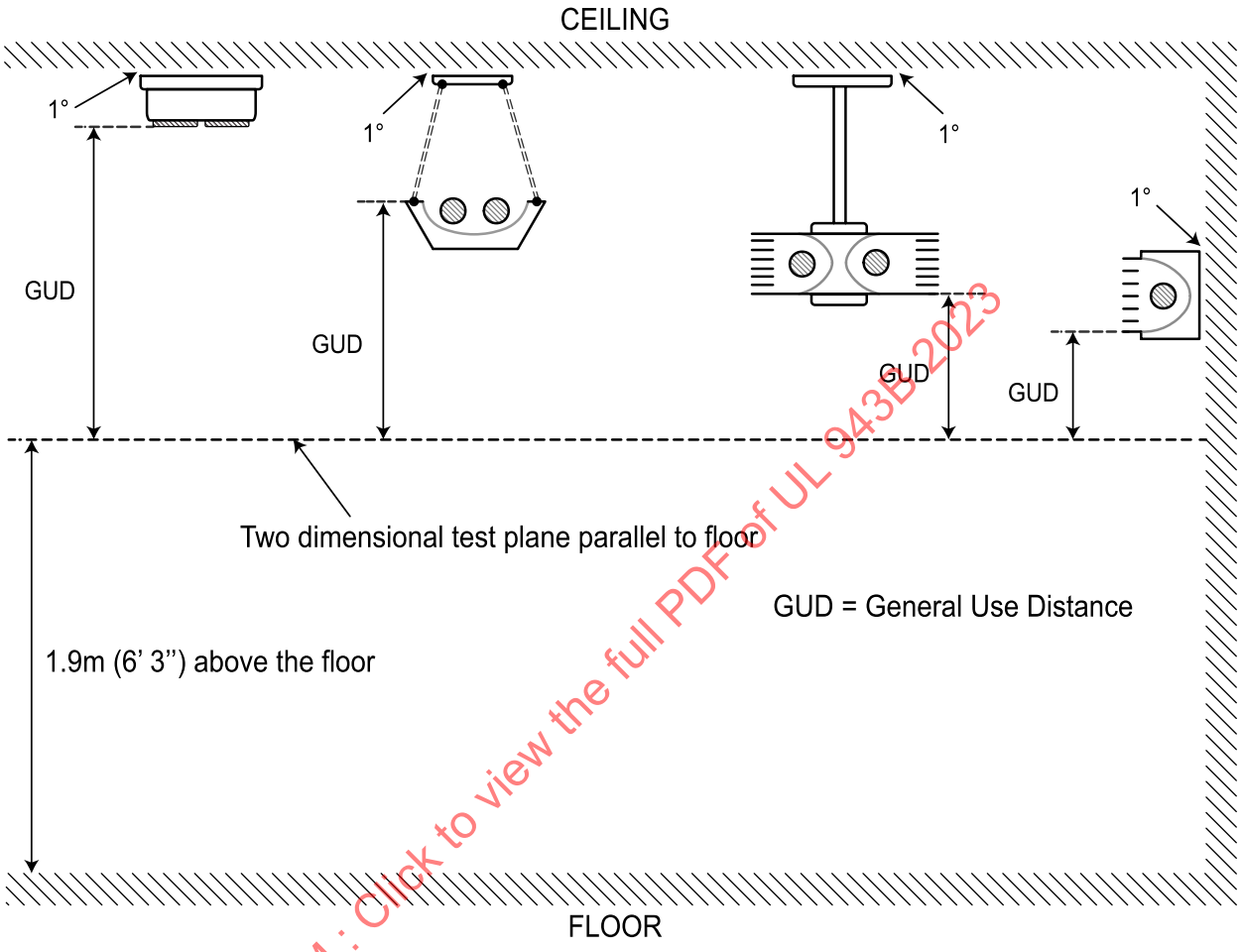
8.6 The measurement distance shall be as follows:

a) For equipment marked by the manufacturer with a minimum mounting height of at least 2.1 m (6 feet 11 inches), compliance shall be determined using the highest weighted actinic reading anywhere along the 2-dimensional test plane located 1.9 m (6 feet 3 inches) above the finished floor as defined in Figure 8.1; and

b) For equipment not marked by the manufacturer with a minimum mounting height, or marked with one that is less than 2.1 m (6 feet 11 inches), compliance shall be determined using a measurement distance from the UV source of 200 mm (8 inches) from the nearest emissive surface in the direction likely to produce the most severe weighted actinic test result.

Figure 8.1

Equipment Mounting Relative to Test Plane



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NOTE: This figure illustrates the two-dimensional test plane, tilt requirement and GUD for different devices and mounting types. It is not intended to illustrate a test apparatus or test setup.

8.7 With regard to 8.6, prior to taking measurements the equipment shall be oriented and operated to produce the most severe test result permitted by its construction and installation instructions. In addition, the equipment shall be offset from its intended mounting surface angle by 1 degree in any direction whenever such an offset is likely to produce a more severe test result. See Figure 8.1.

NOTE: The 1-degree offset represents equipment mounted on uneven or poorly levelled surfaces.

8.8 Controls intended to interrupt equipment operation (e.g. motion sensors, etc.) shall be bypassed or disabled so that the equipment will operate continuously during the photobiological assessment, except as specified in 8.9.

8.9 When compliance with the photobiological assessment relies on controls or timing circuits to continuously operate the UV source on a duty cycle, or to vary the drive current or power to the emitter over time, then the control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

8.10 The results of these assessments are considered acceptable if the equipment achieves a level of Risk Group 0 (Exempt) for weighted actinic and near UV hazards at the measurement distances defined in the preceding clauses. Equipment classified as Risk Group 1, 2 or 3 at these measurement distances are not permitted.

9 Ozone

9.1 Devices that emit ultraviolet radiation at wavelengths less than 250 nm shall be provided with instructions indicating the need to take precautions to ensure that the concentration of ozone is limited to a safe value; see 11.10.

10 Safety Instructions

10.1 The safety instructions shall be a permanent part of the manual but separated in format and preceding all other instructions (such as installation, operation, and maintenance instructions).

10.2 The safety instructions shall include instructions or illustrations to identify important safety features, in addition to the important safeguards listed in 10.5.

10.3 The height of lettering in the text and illustrations of the safety instructions shall be as follows:

a) The phrases "IMPORTANT SAFEGUARDS", "READ AND FOLLOW ALL SAFETY INSTRUCTIONS", and "SAVE THESE INSTRUCTIONS" shall be in letters not less than 4.8 mm (3/16 inch) in height.

b) Other upper-case letters shall not be less than 2.1 mm (1/12 inch) in height.

c) Lower-case letters shall not be less than 1.6 mm (1/16 inch) in height.

10.4 The items may be numbered. The phrases "READ AND FOLLOW ALL SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be first and last, respectively, in a list of items. Other important safeguard items considered appropriate by the manufacturer are to be inserted in between these phrases.

10.5 For all equipment, the safety instructions shall include the following safeguards verbatim or in equally definitive terminology. If a specific safeguard does not apply to a particular type of equipment, the safeguard may be modified or deleted as appropriate.

IMPORTANT SAFEGUARDS

When using electrical equipment, basic safety precautions should always be followed including the following:

READ AND FOLLOW ALL SAFETY INSTRUCTIONS

a) This equipment is designed for use with germicidal UV radiation sources and must be installed in compliance with competent technical directions to prevent risk of personal injury from UV radiation.

b) UV radiation can pose a risk of personal injury. Overexposure can result in injury to eyes and bare skin. To reduce the risk of overexposure this equipment must be installed in accordance with the manufacturer's site planning recommendations. This may include instructions on the relative location of each germicidal system component, the minimum distances between UV generating devices and other objects or surfaces, and protection from line-of-sight exposure to UV radiation in occupied spaces located above the equipment mounting area (e.g., upper floor balconies, open staircases, etc.)

c) UV and optical radiation can be reflected by surrounding surfaces such as ceilings and walls. Since the reflective properties of surfaces can vary widely, it should be considered as part of site planning. Follow the manufacturer's recommendations for selecting appropriate ceiling and wall finishes.

d) IT IS THE RESPONSIBILITY OF THE INSTALLER TO ENSURE THAT PERSONS WILL NOT BE EXPOSED TO EXCESSIVE UV OR OPTICAL RADIATION DURING EQUIPMENT OPERATION. THIS WILL REQUIRE THE INSTALLER TO CONDUCT AN ASSESSMENT OF IRRADIANCE LEVELS IN THE SURROUNDING OCCUPIED SPACES PRIOR TO OCCUPANCY.

e) Equipment should be mounted in locations and at heights where it will not readily be subjected to tampering by unauthorized personnel.

f) Maintenance and servicing of this UV generating equipment shall be performed by authorized personnel. Service personnel must wear appropriate Personal Protective Equipment (PPE). Contact the equipment manufacturer and local jurisdictions for PPE recommendations and guidance.

g) When replacing lamps or UV sources, replace them only with the lamps or sources for which the equipment is marked and intended.

Note: Item (g) applies only to equipment with user-replaceable lamps.

h) The use of accessory equipment not recommended by the manufacturer may cause an unsafe condition.

i) Do not use this equipment for other than intended use.

j) Contact information for the installer's use and reference that includes at least the germicidal system manufacturer's name, address, and either a telephone number or website address.

SAVE THESE INSTRUCTIONS

NOTE: See Annex F (Informative) – Best Practices for Germicidal Equipment Installation

11 Additional Markings and Instructions

11.1 The instruction manual shall include instructions for installation, operation, maintenance, and PPE for maintenance personnel as recommended by the manufacturer. The instructions shall state that installation and servicing shall be performed by qualified personnel.

11.2 The instruction manual for equipment with sunlamp products, lasers or high-intensity mercury vapor discharge lamps shall contain the manufacturer's declaration of conformity to the applicable provisions of applicable US Federal requirements, including 21 CFR, Code of Federal Regulations, Parts 1000 through 1004, and section 1005.25.

11.3 All equipment shall be marked in accordance with Table 11.1, items (1) – (3).

11.4 Equipment tested using a minimum mounting height shall be marked in accordance with Table 11.1, item (4).

11.5 The compartment or area that contains a replaceable UV source shall be marked in accordance with Table 11.1, items (5) and (6). The marking shall be located on the external surface of the equipment where readily visible during any approach to the compartment or area. This item may optionally include item (8).

11.6 For equipment that use replaceable UV sources (e.g., UV generating lamps or UV sources), the lamp replacement marking in Table 11.1, item (7) shall be provided. If there is more than one permitted lamp, this marking may be provided as a table or list.

11.7 The lamp replacement marking shall include at least the manufacturer and model or catalog number of the UV lamp. Alternatively for lamps that have ANSI designations with defined electrical and spectral operating parameters, the ANSI designation complies with this requirement.

NOTE: The lamp replacement marking shall include at least the manufacturer and model or catalog number of the UV lamp. For lamps that have ANSI designations with defined electrical and spectral operating parameters, their ANSI designation complies with the requirement. ANSI designations for some low-pressure UV sources are defined in ANSI C78.81 and ANSI C78.901.

Table 11.1
Additional Markings for UV Germicidal Equipment

Item	Marking	Text	Format[a]	Reference
1	CAUTION – RISK OF PERSONAL INJURY	Verbatim	S24-L1	11.3, 11.5
2	THIS EQUIPMENT IS DESIGNED FOR USE WITH GERMICIDAL LAMPS OR UV SOURCES. STRICT ADHERENCE TO THE INSTALLATION DIRECTIONS IS NECESSARY TO PREVENT OCCUPANT EYE AND SKIN EXPOSURE TO HARMFUL RADIATION	Verbatim	S24-L1	11.3
3	DO NOT INSTALL THIS EQUIPMENT IN A DWELLING	Verbatim	S24-L2	11.3
4	MOUNT THIS EQUIPMENT AT LEAST **[M] [FEET]** ABOVE THE FLOOR		S16-L2	11.4
5	Reserved for future use			
6	EYE INJURY MAY RESULT FROM EXPOSURE TO THE UV SOURCE IN THIS EQUIPMENT. ALWAYS TURN OFF POWER BEFORE SERVICING.	Verbatim	S16-L1	11.5
7	USE ONLY _____ LAMPS		S16-L1	11.6
8	(UV symbol in a triangle)	Symbol from IEC 60417-6040	L1	11.5

[a] Refer to Annex C, Size And Location Designations For Markings, for the definitions of the size and location designations

11.8 The instruction manual shall include detailed information for properly locating the equipment in a given space. This information shall include, as applicable, drawings depicting examples of correct installations, as well as examples of unacceptable installations that may pose a risk of UV overexposure

(e.g., installation at inappropriate heights or orientations, open sightlines between the UV source and exposed upper floors, stairs or walkways, etc.).

11.9 To assist installers with their site planning, the instruction manual shall provide graphical plots of the equipment's UV irradiance profile at the minimum acceptable GUD (see 8.2 and 8.6). Manufacturers may also provide graphical plots of the equipment's UV irradiance at other GUDs.

11.10 When required by 9.1, the instruction manual shall provide instructions to alert the responsible parties to verify safe ozone concentrations in the installation, taking into account the number of products in a given volume of space, the characteristics of the ventilation system, access, and other factors.

PART 2 – UV EMITTER ASSEMBLIES

12 General

12.1 UV emitter assemblies shall comply with one of the applicable safety standards in 1.7 in addition to the requirements in Part 2 of this standard.

12.2 With regard to 12.1, devices that use low-pressure discharge lamps shall comply with the requirements applicable to fluorescent luminaires.

12.3 Devices shall be designed to be permanently mounted in a fixed location, such that it cannot be unmounted or relocated without the use of tools.

12.4 Devices not intended to be adjusted by the end-user shall be designed such that it is not possible to re-orient or refocus the emission source using ordinary tools.

13 Photobiological Assessment

13.1 The device shall be subjected to a photobiological assessment for actinic and near UV hazards from 200 nm through 400 nm in accordance with the requirements in CSA C22.2 No. 62471 (in Canada) or IEC 62471 (in the United States). This assessment shall be used to determine the risk group of the device for these hazards.

13.2 At the manufacturer's request, the photobiological assessment in 13.1 may alternatively be conducted in accordance with IES RP-27.1 for actinic and near UV hazards from 200 nm through 400 nm. This assessment shall be used to determine the risk group of the device for these hazards.

13.3 If the equipment employs multiple UV sources, all sources must be simultaneously energized during the measurement in 13.1 unless an integral control regulates the selection or timing of the UV sources. Such an integral control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

13.4 The measurement instrument shall have a sensor with an aperture limiting the detector field of view cone in accordance with IEC 62471-6 or IES RP-27.1, as applicable.

13.5 This assessment shall be conducted using a measurement distance from the radiation source of 200 mm (8 inches) in the direction likely to produce the most severe test result.

13.6 The equipment shall be oriented and operated to produce the most severe test result permitted by its construction and installation instructions.

13.7 Controls intended to interrupt equipment operation (e.g. motion sensors, etc.) shall be bypassed or disabled so that the equipment will operate continuously during the photobiological assessment, except as specified in 13.8.

13.8 When compliance with the photobiological assessment relies on controls or timing circuits to continuously operate the UV source on a duty cycle, or to vary the drive current or power to the emitter over time, then the control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

13.9 The results of this assessment shall be used to select the product and packaging markings specified in Section 16, Additional Markings and Instructions.

14 Ozone

14.1 Devices that emit ultraviolet radiation at wavelengths less than 250 nm shall be provided with instructions that specify the need to take precautions to ensure that the concentration of ozone is limited to a safe value; see 16.10.

15 Safety Instructions

15.1 The safety instructions shall be a permanent part of the manual but separated in format and preceding all other instructions (such as installation, operation, and maintenance instructions).

15.2 The safety instructions shall include instructions or illustrations to identify important safety features, in addition to the important safeguards specified in 15.5.

15.3 The height of lettering in the text and illustrations of the safety instructions shall be as follows:

a) The phrases "IMPORTANT SAFEGUARDS", "READ AND FOLLOW ALL SAFETY INSTRUCTIONS", and "SAVE THESE INSTRUCTIONS" shall be in letters not less than 4.8 mm (3/16 inch) in height.

b) Other upper-case letters shall not be less than 2.1 mm (1/12 inch) in height.

c) Lower-case letters shall not be less than 1.6 mm (1/16 inch) in height.

15.4 The items may be numbered. The phrases "READ AND FOLLOW ALL SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be first and last, respectively, in a list of items. Other important safeguard items considered appropriate by the manufacturer are to be inserted in between these phrases.

15.5 For all equipment, the safety instructions shall include the following safeguards verbatim or in equally definitive terminology. If a specific safeguard does not apply to a particular type of equipment, the safeguard may be modified or deleted as appropriate.

IMPORTANT SAFEGUARDS

When using electrical equipment, basic safety precautions should always be followed including the following:

READ AND FOLLOW ALL SAFETY INSTRUCTIONS

a) This equipment is designed for use with germicidal UV radiation sources and must be installed in compliance with competent technical directions to prevent risk of personal injury from UV radiation.

b) THESE DEVICES ARE NOT INTENDED FOR GENERAL-PURPOSE ILLUMINATION. They are assigned a Risk Group level based on the intensity and wavelength of the radiant energy they produce. UV radiation can pose a risk of personal injury. Overexposure can result in injury to eyes and bare skin. To reduce the risk of overexposure this equipment must be installed in accordance with the manufacturer's site planning recommendations.

c) THESE EMMITER ASSEMBLIES ARE NOT STAND-ALONE DEVICES. They are intended for use only as part of germicidal systems. Consult the safety instructions of the germicidal system to confirm compatibility.

d) IT IS THE RESPONSIBILITY OF THE INSTALLER TO ENSURE THAT PERSONS WILL NOT BE EXPOSED TO EXCESSIVE UV OR OPTICAL RADIATION DURING EQUIPMENT OPERATION. THIS WILL REQUIRE THE INSTALLER TO CONDUCT AN ASSESSMENT OF ALL SITE AND EQUIPMENT SAFEGUARDS TO ENSURE THE SYSTEM IS OPERATING IN ACCORDANCE WITH THE SYSTEM MANUFACTURER'S INSTRUCTIONS.

e) Equipment should be mounted in locations and at heights where it will not readily be subjected to tampering by unauthorized personnel.

f) Maintenance and servicing of this UV generating equipment shall be performed by authorized personnel. Service personnel must wear appropriate Personal Protective Equipment (PPE). Contact the equipment manufacturer and local jurisdictions for PPE recommendations and guidance.

g) When replacing lamps or UV sources, replace them only with the lamps or sources for which the equipment is marked and intended.

Note: Item (g) applies only to equipment with user-replaceable lamps.

h) The use of accessory equipment not recommended by the manufacturer may cause an unsafe condition.

i) Do not use this equipment for other than intended use.

j) Contact information for the installer's use and reference that includes at least the germicidal system manufacturer's name, address, and either a telephone number or website address.

SAVE THESE INSTRUCTIONS

16 Additional Markings and Instructions

16.1 The instruction manual shall include instructions for installation, operation, maintenance, and PPE for qualified service personnel as recommended by the manufacturer. The instructions shall state that installation and servicing should be performed by qualified service personnel.

16.2 The instruction manual for equipment with sunlamp products, lasers or high-intensity mercury vapor discharge lamps shall contain the manufacturer's declaration of conformity to the applicable provisions of applicable US Federal requirements, including CFR 21, Parts 1000 through 1004, and section 1005.25.

16.3 All emitters shall be marked in accordance with Table 16.1, items (1) – (4).

16.4 The compartment or area that contains a replaceable UV source shall be marked in accordance with Table 16.1, items (5) and (6). The marking shall be located on the external surface of the equipment where readily visible during any approach to the compartment or area. This item may optionally include item (8).

16.5 For equipment that uses replaceable UV sources (e.g., UV generating lamps), the lamp replacement marking in Table 16.1, item (7) shall be provided. If there is more than one permitted lamp, this marking may be provided as a table or list.

16.6 The lamp replacement marking shall include at least the manufacturer and model or catalog number of the UV lamp. Alternatively for lamps that have ANSI designations with defined electrical and spectral operating parameters, the ANSI designation complies with this requirement.

NOTE: The lamp replacement marking shall include at least the manufacturer and model or catalog number of the UV lamp. For lamps that have ANSI designations with defined electrical and spectral operating parameters, their ANSI designation complies with the requirement. ANSI designations for some low-pressure UV sources are defined in ANSI C78.81 and ANSI C78.901.

Table 16.1
Additional Markings

Item	Marking	Text	Format[a]	Reference
1	CAUTION – RISK OF PERSONAL INJURY	Verbatim	S24-L1	16.3, 16.4
2	THIS EQUIPMENT IS DESIGNED FOR USE WITH GERMICIDAL LAMPS OR UV SOURCES. STRICT ADHERENCE TO THE INSTALLATION DIRECTIONS IS NECESSARY TO PREVENT OCCUPANT EYE AND SKIN EXPOSURE TO HARMFUL RADIATION	Verbatim	S24-L1	16.3
3	DO NOT INSTALL THIS EQUIPMENT IN A DWELLING	Verbatim	S24-L2	16.3
4	THESE EMITTER ASSEMBLIES ARE NOT STAND-ALONE DEVICES. Consult safety instructions of the germicidal system to confirm compatibility.	Verbatim	S24-L2	16.3
5	Reserved for future use			
6	EYE INJURY MAY RESULT FROM EXPOSURE TO THE UV SOURCE IN THIS EQUIPMENT. ALWAYS TURN OFF POWER BEFORE SERVICING.	Verbatim	S16-L1	16.4
7	USE ONLY _____ LAMPS		S16-L1	16.5
8	(UV symbol in a triangle)	Symbol from IEC 60417-6040	L1	16.4
9	Risk Group Classification – Product and Packaging Markings		S24-L1, S24-L4	16.8

[a] Refer to Annex C, Size And Location Designations For Markings for the definitions of the size and location designations.

16.7 To assist UV germicidal equipment and systems designers, and installers with their site planning, the instruction manual shall provide graphical plots of the equipment's UV irradiance profile.

16.8 With regard to 13.8, all emitters shall be provided with all the applicable markings in 16.9 and 16.10, unless their emitters are classified as Risk Group 0 (Exempt) for actinic and near UV hazards. Emitters with higher classifications shall be provided with product and packaging markings that correspond to their risk group, as follows:

a) Product markings – Format S24-L1, layout in accordance with 16.9, provided on the product.

b) Packaging markings – Format S24-L4 and S24-L5, layout in accordance with 16.9, provided on the product's outer packaging where visible to the user prior to opening, and on any instruction sheet packed with the product.

16.9 The product and packaging markings in 16.8 shall be presented in bold block print within a black-bordered two-section box on a yellow background, as follows:

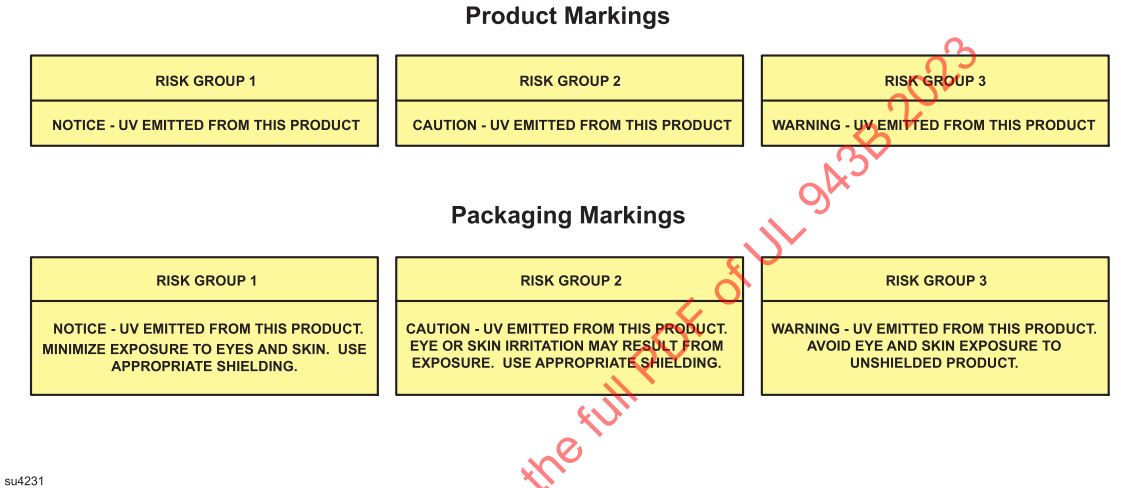
a) The risk group classification in the upper box; and

b) The required labeling, information and guidance text in the lower box.

See Figure 16.1 for graphical examples of the required verbiage and format.

Figure 16.1

Product and Packaging Markings by Risk Group Classification



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16.10 When required by 14.1, the instruction manual shall provide instructions to alert the responsible parties to verify safe ozone concentrations in the installation, taking into account the number of products in a given volume of space, the characteristics of the ventilation system, access, and other factors.

PART 3 – GERMICIDAL SYSTEMS

17 General

17.1 System components that are not otherwise specified in Section 18, Safeguards, shall comply with one of the applicable safety standards in 1.7 in addition to the requirements in Part 3 of this Standard.

17.2 All system components shall either be provided by the system manufacturer, or clearly specified in the installation instructions as a component that the installer is required to source separately. See 21.3(b).

17.3 All emitters in a germicidal system shall comply with the requirements of either Part 1 or Part 2 of this Standard.

18 Safeguards

18.1 UV germicidal systems shall incorporate at least two independent electrical or mechanical safeguards (i.e., primary and secondary) to reduce the overexposure risk if the system is inadvertently or intentionally operating while the treated space is occupied. This may be accomplished with any combination of site and equipment safeguards. Safeguards shall be installed near or within the treated space to reduce the likelihood of occupancy immediately before or during emitter operation. Examples of such safeguards include:

a) Access controls that require the use of a key, an access code or the like, so that unauthorized persons are unlikely to be able to engage the system;

b) Entry point interlock switches or sensors that disengage emitters if someone tries to access the treated space;

c) A sensor or detector network within the treated space that prevents emitters from energizing if any occupancy is detected;

d) Arming switches located within the treated space, requiring an instructed operator to enter the space and verify vacancy before engaging the system; and

NOTE: For arming switches that are not mechanically keyed (i.e., an employee access badge and reader) the system shall only permit emitter engagement by the same person that cleared the room to arm the system.

e) Controls with a defined order of operation intended to prevent overexposure of the instructed operator if they operate the controls out of sequence.

NOTE 1: Signage, product markings and operating instructions are not to be considered for the purpose of complying with this requirement.

NOTE 2: Primary and secondary safeguards are required for each scenario. Depending on system design and operating instructions, more than two safeguards may be required to address all scenarios for the germicidal system.

18.2 Safeguards shall operate independently of one another. The failure of any single safeguard shall not disable or degrade the remaining safeguards, unless the fault also results in a safe shutdown. Compliance is determined by application of the requirements in Section 19, Safeguard Assessment.

NOTE: Safeguard failures include those caused by occupants or instructed operator error or misuse.

18.3 When a safeguard is mounted in the treated space, or is accessible to an end-user regardless of where it is mounted, any adjustments, intentional or otherwise, that can be accomplished by hand or by using ordinary tools (e.g., blocking or painting over a sensor, disconnecting a wire or connector, etc.) shall either:

a) Not affect the operation of the remaining safeguards;

b) Prevent system engagement and operation until repairs can be made; or

c) Result in a safe shutdown.

18.4 Safeguards are considered integral components of a germicidal system and shall be selected and used in line with their ratings, markings and intended use. Safeguards shall comply with applicable safety standards as components of the system, in accordance with Section 2, Components.

18.5 System components that comply with one of the following standards are considered to comply with 18.4 when they are used in accordance with their ratings, markings and intended use:

a) In Canada:

1) ULC 60839-11-1;

2) CSA C22.2 No. 14;

3) ULC-S306;

4) CSA C22.2 No. 205;

5) CSA E60730-1;

6) CSA C22.2 No. 60947-1, including the Part standards that corresponds to the system component;

7) CSA C22.2 No. 61058-1, including the Part standards that corresponds to the system component; or

8) CSA-E61496-1, including the Part standards that corresponds to the system component.

b) In the United States:

1) UL 294;

2) UL 508;

3) UL 639;

4) UL 916;

5) UL 60730-1;

6) UL 60947-1, including the Part standards that corresponds to the system component;

7) UL 61058-1, including the Part standards that corresponds to the system component; or

8) UL 61496-1, including the Part standards that corresponds to the system component.

Examples of such components include switches, relays, sensors, controls, electrically operated door locks and emergency stop devices.

18.6 A relay shall have appropriate ratings (i.e., voltage, current, or watts) applicable for the application. In addition, a relay that operates (make or break) non-isolated circuits shall be rated based on load type as specified below:

a) LED array loads are evaluated as resistive loads.

b) AC transformer (magnetic) loads are evaluated as general purpose loads. Relays with this rating can also be used with LED array loads.

c) Electronic (switch mode) transformers, LED drivers, fluorescent ballasts, and LED light engines are evaluated as tungsten lamp loads with endurance testing in accordance with CSA-C22.2 No. 14/UL 508, requirements for electronic fluorescent ballasts. Relays with this rating can also be used with LED array and AC transformer (magnetic) loads.

18.7 If safeguards depend upon on the operation of a wireless communications network (i.e., Bluetooth, etc.), then this network and its related components shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

18.8 If motion detection is used as a safeguard, then:

a)The motion detection control (i.e., motion detectors and all associated circuitry) is considered a critical control function, and shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements; and

b) The minimum detection range of this control or system shall cover the entirety of the treated space within the equipment's exempt perimeter. This coverage shall be determined using the test procedure in Annex D, Motion Detectors – Determination of Coverage Area.

19 Safeguard Assessment

19.1 The germicidal system, with all necessary electrical and mechanical components in place, shall be evaluated to assess each site or equipment safeguard intended to comply with 18.2. This assessment may be performed as an engineering review (e.g., fault tree analysis), a series of actual faults on a representative system, or any combination thereof.

19.2 The assessment is considered acceptable if any single safeguard failure under any scenario results in the emitters shutting down before a person occupying or entering the treated space can be exposed to excessive UV or optical energy. In addition, no instance of safeguard failure shall affect the operation of the remaining safeguards unless the failure:

a) Prevents system engagement and operation until repairs can be made; or

b) Results in a safe shutdown.

19.3 For this assessment the germicidal system shall be configured in the most disadvantageous configuration permitted by the system's installation and operating instructions. Depending on the complexity of the system, this may require selecting and assessing more than one configuration. For each selected configuration, the following failure modes shall be considered:

a) Electrical faults that simulate the possible adverse operating states for the safeguard (e.g., always open, always closed, not responsive to signals, electronic component open or shorted fault, etc.);

b) Mechanical faults (e.g., connector disengaged or improperly engaged, physically damaged sensor, switch or control stuck in position, relay or contactor stuck open or closed, etc.);

c) Instructed operator or occupant errors or misuse that can be accomplished by hand or by using ordinary tools (e.g., defeating the access-control feature on a control, blocking or otherwise disabling a sensor, etc.); and

d) Incorrect order of operations (e.g., activating a series of controls in any incorrect sequence permitted by the physical construction of the system).

19.4 With regard to 19.3(a), internal electrical faults are not required on controls that comply with one of the following:

a) Type 2 protective controls or Type 2 operating controls that comply with CSA E60730-1 or UL 60730-1, and the Part 2 standard applicable to the component;

b) Safety controls that comply with CSA C22.2 No. 205 or UL 916 or

c) Controls with an access control endurance rating of IV that comply with ULC 60839-11-1 or UL 294;

d) Switches, contactors or industrial control relays that comply with their applicable standard in 18.5 with a minimum 100,000 cycle endurance rating for their intended load in the germicidal system; or

e) Type 4 electro-sensitive protective equipment (ESPE) that comply with CSA E61496-1 or UL 61496-1.

19.5 19.4 does not apply to any other system components that may be electrically or mechanically connected to these devices, which are subject to the electrical faults in 19.3(a).

19.6 Each safeguard failure shall be simulated under each of the following operating scenarios, in turn:

a) Scenario No. 1 – The instructed operator engages the germicidal system, a single safeguard is faulted, then someone attempts to access the treated space.

b) Scenario No. 2 – A single safeguard is faulted, the instructed operator engages the germicidal system, then a person attempts to access the treated space.

c) Scenario No. 3 – The instructed operator engages the germicidal system while a stationary person is occupying the treated space.

NOTE 1: Scenario Nos. 1 and 2 shall consider all possible entry options as well as entry during any phase of the initialization cycle (e.g.: during arming, clearing the space, and emitter initialization). Also, when there are two or more access points, consider that a person other than the instructed operator may enter the space after the system is armed/cleared but before dosing begins.

NOTE 2: Scenario No. 3 is not required for germicidal systems that cannot be engaged without the instructed operator first entering the treated space and operating one or more safeguards (e.g., controls) to arm the system during visual inspection of the area.

20 Safety Instructions

20.1 The safety instructions shall be a permanent part of the manual but separated in format and preceding all other instructions (such as installation, operation, and maintenance instructions).

20.2 The safety instructions shall include instructions or illustrations to identify important safety features, in addition to the important safeguards listed in 20.5.

20.3 The height of lettering in the text and illustrations of the safety instructions shall be as follows:

a) The phrases "IMPORTANT SAFEGUARDS", "READ AND FOLLOW ALL SAFETY INSTRUCTIONS", and "SAVE THESE INSTRUCTIONS" shall be in letters not less than 4.8 mm (3/16 inch) in height.

b) Other upper-case letters shall not be less than 2.1 mm (1/12 inch) in height.

c) Lower-case letters shall not be less than 1.6 mm (1/16 inch) in height.

20.4 The items may be numbered. The phrases "READ AND FOLLOW ALL SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be first and last, respectively, in a list of items. Other important safeguard items considered appropriate by the manufacturer are to be inserted in between these phrases.

20.5 For all equipment, the safety instructions shall include the following safeguards verbatim or in equally definitive terminology. If a specific safeguard does not apply to a particular type of equipment, the safeguard may be modified or deleted as appropriate.

IMPORTANT SAFEGUARDS

When using electrical equipment, basic safety precautions should always be followed including the following:

READ AND FOLLOW ALL SAFETY INSTRUCTIONS

a) THIS EQUIPMENT IS DESIGNED FOR USE WITH GERMICIDAL LAMPS OR UV SOURCES. STRICT ADHERENCE TO THE INSTALLATION DIRECTIONS IS NECESSARY TO PREVENT OCCUPANT EYE AND SKIN EXPOSURE TO HARMFUL RADIATION.

b) This equipment is designed for use with germicidal UV radiation sources and must be installed in compliance with competent technical directions to prevent risk of personal injury from UV radiation.

c) UV radiation can pose a risk of personal injury. Overexposure can result in injury to eyes and bare skin. To reduce the risk of overexposure this equipment must be installed in accordance with the manufacturer's site planning recommendations, including instructions on the relative location of each germicidal system component, the minimum distances between UV-generating devices and other objects or surfaces, and protection from line-of-sight exposure to UV radiation in occupied spaces located above the equipment mounting area (e.g., accessible upper floor balconies, open staircases, etc.).

d) Follow the manufacturer's recommendations for selecting appropriate ceiling and wall finishes.

e) IT IS THE RESPONSIBILITY OF THE INSTALLER TO ENSURE THAT PERSONS WILL NOT BE EXPOSED TO EXCESSIVE UV OR OPTICAL RADIATION DURING EQUIPMENT OPERATION. THIS WILL REQUIRE THE INSTALLER TO CONDUCT AN ASSESSMENT OF ALL SITE AND EQUIPMENT SAFEGUARDS TO ENSURE THE SYSTEM IS OPERATING IN ACCORDANCE WITH THE SYSTEM MANUFACTURER'S INSTRUCTIONS, INCLUDING AN ASSESSMENT OF IRRADIANCE LEVELS IN THE SURROUNDING OCCUPIED SPACES.

f) Equipment should be mounted in locations and at heights where it will not readily be subjected to tampering by unauthorized personnel.

g) Maintenance and servicing of this UV generating equipment shall be performed by authorized personnel. Service personnel must wear appropriate Personal Protective Equipment (PPE). Contact the equipment manufacturer and local jurisdictions for PPE recommendations and guidance.

h) When replacing lamps or UV sources, replace them only with the lamps or sources for which the equipment is marked and intended.

NOTE: Item (h) applies only to equipment with user-replaceable lamps.

i) The use of accessory equipment not recommended by the manufacturer may cause an unsafe condition.

j) Do not use this equipment for other than intended use.

SAVE THESE INSTRUCTIONS

21 Additional Markings and Instructions

21.1 The instruction manual shall include instructions for system installation, operation, maintenance, and PPE for qualified service personnel as recommended by the manufacturer. The instructions shall state that installation and servicing should be performed by qualified service personnel.

21.2 The instruction manual for equipment with sunlamp products, lasers or high-intensity mercury vapor discharge lamps shall contain the manufacturer's declaration of conformity to the applicable provisions of applicable US Federal requirements, including CFR 21, Parts 1000 through 1004, and section 1005.25.

21.3 The installation and operating instructions shall include at least the following items:

a) A complete parts list of all required system components, which may also include photographs or line drawings of all system components and controls;

b) All required components that are not provided by the system manufacturer shall be specified by manufacturer and catalog number. Alternatively, they can be specified parametrically (e.g., by electrical and mechanical parameters) only if the parametric description was taken into account during the safeguard assessment of the component;

Note: A parametric description that permits the use of components that would not comply with the Safeguard Assessment in Section 19, Safeguard Assessment, does not comply with this requirement.

c) A wiring schematic of the germicidal system illustrating the correct electrical connections of all components;

d) A graphical representation of the configuration of the treated space for which the germicidal system is intended, which includes the relative locations of all permitted access points and features (e.g., entryways and doors);

e) A graphical representation of the relative locations of all safeguards to permit the system to operate as intended;

f) Instructions on the correct commissioning and operation of the germicidal system; and

g) Contact information for the installer's use and reference that includes at least the germicidal system manufacturer's name, address, and either a telephone number or website address.

21.4 All emitters shall be marked in accordance with Table 21.1, items (1) – (3).

21.5 The compartment or area that contains a replaceable UV source shall be marked in accordance with Table 21.1, items (4) and (5). The marking shall be located on the external surface of the equipment where readily visible during any approach to the compartment or area. This item may optionally include item (7).

21.6 For equipment that uses replaceable emission sources (e.g., UV generating lamps), the lamp replacement marking in Table 21.1, item (6) shall be provided. If there is more than one permitted lamp, this marking may be provided as a table or list,

NOTE: The lamp replacement marking shall include at least the manufacturer and model or catalog number of the UV lamp. For lamps that have ANSI designations with defined electrical and spectral operating parameters, their ANSI designation complies with the requirement. ANSI designations for some low-pressure UV sources are defined in ANSI C78.81 and ANSI C78.901.

Table 21.1
Additional Markings for Germicidal Systems

Item	Marking	Text	Format[a]	Reference
1	CAUTION – RISK OF PERSONAL INJURY	Verbatim	S24-L1	21.4, 21.5
2	THIS EQUIPMENT IS DESIGNED FOR USE WITH GERMICIDAL LAMPS OR UV SOURCES AND MUST BE INSTALLED IN COMPLIANCE WITH COMPETENT TECHNICAL DIRECTIONS TO PREVENT THE USER'S EYE AND BARE SKIN FROM EXPOSURE TO HARMFUL UV OR OPTICAL RADIATION	Verbatim	S24-L1	21.4
3	DO NOT INSTALL THIS EQUIPMENT IN A DWELLING	Verbatim	S24-L2	21.4
4	Reserved for future use			
5	EYE INJURY MAY RESULT FROM EXPOSURE TO THE UV SOURCE IN THIS EQUIPMENT. ALWAYS TURN OFF POWER BEFORE SERVICING.	Verbatim	S16-L1	21.5
6	USE ONLY _____ LAMPS		S16-L1	21.6
7	(UV symbol in a triangle)	Symbol from IEC 60417-6040	L1	21.5

[a] Refer to Annex C, Size And Location Designations For Markings for the definitions of the size and location designations

21.7 The instruction manual shall include detailed information for properly locating the components of a system in a given space. This information shall include, as applicable, drawings depicting examples of correct installations, as well as examples of unacceptable installations that may pose a risk of UV overexposure (e.g., installation at inappropriate heights, locations or orientations, open sightlines between the radiation source and exposed upper floors, stairs or walkways, etc.).

22 Warning Labels

22.1 The manufacturer shall provide labels that are intended to be affixed adjacent to points of access to the treated area. They shall be marked with the word “WARNING”, and the following or equivalent statement, “RISK OF PERSONAL INJURY. AN ULTRAVIOLET (UV) GERMICIDAL SYSTEM IS INSTALLED IN THIS AREA. TO PREVENT UV OVEREXPOSURE, DO NOT ENTER THIS ROOM WHEN THE SYSTEM IS IN OPERATION.”

22.2 The markings specified in 22.1 shall be in letters not less than 6.4 mm (1/4 inch) high and printed on a contrasting background.

PART 4 – UV GERMICIDAL RETROFIT KITS

23 General

23.1 UV germicidal retrofit kits shall comply with construction, performance and marking requirements of the standards specified below unless specifically superseded by a requirement in this standard:

a) UL 1598C; and

b) CSA C22.2 No. 250.1.

23.2 UV germicidal retrofit kits shall be designed only for conversion of luminaires that are permanently mounted (fixed location), such that the complete equipment cannot be unmounted or relocated without the use of tools.

23.3 The UV emission source shall be designed so that it cannot be unmounted or disassembled without the use of tools.

23.4 The UV emission source shall be provided integral to the retrofit kit and it shall not be user-replaceable. A UV source that is mounted on or secured to lampholders and that can be removed using ordinary tools or by hand is considered user-replaceable and not in compliance with this clause.

24 Photobiological Assessment

24.1 The device shall be subjected to a photobiological assessment for actinic and near UV hazards from 200 nm through 400 nm in accordance with the requirements in CSA C22.2 No. 62471 (in Canada) or IEC 62471 (in the United States). This assessment shall be used to determine the risk group of the device for these hazards.

24.2 At the manufacturer's request, the photobiological assessment in 24.1 may alternatively be conducted in accordance with IES RP-27.1 for actinic and near UV hazards from 200 nm through 400 nm. This assessment shall be used to determine the risk group of the device for these hazards.

24.3 If the equipment employs multiple UV sources, all sources must be simultaneously energized during the measurement in 24.1 unless an integral control regulates the selection or timing of the UV sources. Such an integral control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

24.4 TThe measurement instrument shall have a sensor with an aperture limiting the detector field of view cone in accordance with IEC 62471-6 or IES RP-27.1, as applicable.

24.5 This assessment shall be conducted using a measurement distance from the radiation source of 200 mm (8 inches) in the direction likely to produce the most severe test result.

24.6 The equipment shall be oriented and operated to produce the most severe test result permitted by its construction and installation instructions. The assessment shall be conducted using the worst-case installation and adjustment permitted by its construction, with any removable guards or panels removed.

24.7 Any panels or diffusers that must remain in place during the photobiological assessment in order to achieve acceptable test results shall be secured at the factory in such a manner that they are not removable from the room side using ordinary tools or by hand. If secured by snap-fit or interference fit, the panel or diffuser shall remain in place during the Snap-In Or Tab-Mounted Parts Pull Test Without Conduit Opening in CSA No. 250.0 or UL 1598. Panels or diffusers that do not comply with these requirements shall be removed for this assessment.

24.8 Controls intended to interrupt equipment operation (e.g., motion sensors, timers, etc.) shall be bypassed or disabled so that the equipment will operate continuously during the photobiological assessment.

24.9 When compliance with the photobiological assessment relies on timing circuits that operate the UV source on a continuous duty cycle, or circuits that vary the drive current or power to the emission source over time, the control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

24.10 The results of this assessment are considered acceptable if the equipment achieves a level of Risk Group 0 (Exempt) for weighted actinic and near UV hazards at the 200 mm (8 inches) measurement distance defined in 24.5. Equipment classified as Risk Group 1, 2, or 3 are not permitted.

25 Ozone

25.1 Devices that emit ultraviolet radiation at wavelengths less than 250 nm shall be provided with instructions indicating the need to take precautions to ensure that the concentration of ozone is limited to a safe value; see 26.3.

26 Additional Markings and Instructions

26.1 The installation instructions shall include the markings in Table 26.1, items (1) – (2).

26.2 The product marking in Table 26.1, item (3) shall appear on the retrofit kit where visible to users attempting to access the UV source.

Table 26.1
Additional Markings for UV Germicidal Retrofit Kits

Item	Marking	Text	Format[a]	Reference
1	DO NOT INSTALL THIS EQUIPMENT IN A DWELLING	Verbatim	S24-L2	26.1
2	CAUTION – RISK OF PERSONAL INJURY. DO NOT USE THIS RETROFIT KIT TO CONVERT PORTABLE OR HAND-HELD LUMINAIRES.	Verbatim	S24-L2	26.1
3	DO NOT DISASSEMBLE. DO NOT OPERATE IF DAMAGED. THIS EQUIPMENT PRODUCES UV ENERGY AND IS NOT USER-SERVICEABLE. REFER ALL SERVICING TO QUALIFIED SERVICE PERSON ONLY	Verbatim	S24-L1	26.2

[a] Refer to Annex C, Size And Location Designations For Markings for the definitions of the size and location designations

26.3 When required by 25.1, the instruction manual shall provide instructions to alert the responsible parties to verify safe ozone concentrations in the installation, taking into account the number of products in a given volume of space, the characteristics of the ventilation system, access, and other factors.

PART 5 – CONTAINED UV GERMICIDAL EQUIPMENT

27 General

27.1 Contained UV germicidal equipment shall comply with one of the applicable safety standards in 1.7 in addition to the requirements in Part 5 of this standard.

27.2 Devices that use low-pressure discharge lamps shall comply with the requirements applicable to fluorescent luminaires.

27.3 Devices with UV sources that are not intended to be serviced by the user shall be designed so that they cannot be accessed without the use of tools, and shall be marked in accordance with 32.6.

27.4 Performing a user maintenance operation while the equipment is energized (e.g.: replacing a user-replaceable light source, UV source or air filter) shall not expose the user to excessive UV as determined by compliance with the Photobiological Assessment; see 28.6. If an interlock is used to prevent UV overexposure during user maintenance, then:

a) The interlock shall disconnect power from the UV source before the user can be exposed to UV energy in excess of Risk Group 0 (Exempt) limits;

b) The interlock shall comply with the requirements in Annex E.

27.5 Equipment that incorporate electric motors or filters shall comply with the following referenced sections of UL 867:

a) Motors and Motor Overcurrent Protection

b) Rotating Parts

c) Enclosures and Guards

d) Filters

28 Photobiological Assessment

28.1 Equipment shall not pose a risk of personal injury to persons due to UV overexposure when installed, tested and operated in accordance with the manufacturer's instructions and the requirements of this Standard.

28.2 In order to determine compliance with 28.1, the device shall be subjected to a photobiological assessment for actinic and near UV hazards from 200 nm through 400 nm in accordance with the requirements in CSA C22.2 No. 62471 (in Canada) or IEC 62471 (in the United States). This assessment shall be used to determine the risk group of the device for these hazards.

28.3 At the manufacturer's request, the photobiological assessment in 28.2 may alternatively be conducted in accordance with IES RP-27.1 for actinic and near UV hazards from 200 nm through 400 nm. This assessment shall be used to determine the risk group of the device for these hazards.

28.4 The measurement instrument shall have a sensor with an aperture limiting the detector field of view cone in accordance with IEC 62471-6 or IES RP-27.1, as applicable.

28.5 The measurement distance from the equipment to the measuring instrument shall be 200 mm (8 inches) from the point on the equipment likely to produce the most severe test result.

28.6 With regard to 28.5, the equipment shall be set up, oriented and operated so as to produce the most severe test result permitted by its construction and operating instructions. This includes repositioning or removing any covers, lenses, filter elements or accessories that can be adjusted, removed or serviced by the user.

28.7 Controls intended to interrupt equipment operation (e.g., motion sensors, etc.) shall be bypassed or disabled so that the equipment will operate continuously during the photobiological assessment, except as specified in 28.8.

28.8 When compliance with the photobiological assessment relies on controls or timing circuits to continuously operate the UV source on a duty cycle, or to vary the drive current or power to the emitter over time, then the control shall be additionally evaluated as a safety-related electronic circuit (SREC) in accordance with Annex B, Safety-Related Electronic Circuit (SREC) Requirements.

28.9 The result of this assessment is considered acceptable if the equipment achieves a level of Risk Group 0 (Exempt) for actinic and near UV hazards. Equipment classified as Risk Group 1, 2 or 3 are not permitted.

29 Ozone

29.1 Portable equipment evaluated per 1.7(c) that emit ultraviolet radiation at wavelengths less than 250 nm shall comply with the Ozone Test in CSA C22.2 No. 187 / UL 867.

29.2 Equipment evaluated per 1.7(a), or 1.7(b) that emit ultraviolet radiation at wavelengths less than 250 nm shall either:

a) Be provided with instructions indicating the need to take precautions to ensure that the concentration of ozone is limited to a safe value, and that the equipment shall not be used in dwellings; see 32.5; or

b) Comply with the Ozone Test in CSA C22.2 No. 187 / UL 867.

NOTE – Equipment with an ozone monitoring circuit or an interlock mechanism to control ozone production are not addressed by this document, and may require a separate evaluation.

30 Stability

30.1 When conducting the Stability Test in UL 153, the test is to be conducted under conditions most likely to cause the equipment to overturn. In addition to the test conditions in UL 153, the following conditions shall be included if they result in less stability:

a) The position of all doors, drawers, casters, and other movable or adjustable parts, including that of a supply cord, if any, resting on the surface supporting the equipment;

b) Connection of or omission of any attachment made available by or recommended by the manufacturer; and

c) Direction in which the equipment is tipped.

31 Safety Instructions

31.1 The safety instructions shall be a permanent part of the manual but separated in format and preceding all other instructions (such as installation, operation, and maintenance instructions).

31.2 The safety instructions shall include instructions or illustrations to identify important safety features, in addition to the important safeguards listed in 31.5.

31.3 The height of lettering in the text and illustrations of the safety instructions shall be as follows:

a) The phrases "IMPORTANT SAFEGUARDS", "READ AND FOLLOW ALL SAFETY INSTRUCTIONS", and "SAVE THESE INSTRUCTIONS" shall be in letters not less than 4.8 mm (3/16 inch) in height.

b) Other upper-case letters shall not be less than 2.1 mm (1/12 inch) in height.

c) Lower-case letters shall not be less than 1.6 mm (1/16 inch) in height.

31.4 The items may be numbered. The phrases "READ AND FOLLOW ALL SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be first and last, respectively, in a list of items. Other important safeguard items considered appropriate by the manufacturer are to be inserted in between these phrases.

31.5 For all equipment, the safety instructions shall include the following safeguards verbatim or in equally definitive terminology. If a specific safeguard does not apply to a particular type of equipment, the safeguard may be modified or deleted as appropriate.

IMPORTANT SAFEGUARDS

When using electrical equipment, basic safety precautions should always be followed including the following:

READ AND FOLLOW ALL SAFETY INSTRUCTIONS

a) This equipment uses an ultraviolet (UV) source and must be used in compliance with its markings and instructions to prevent the user's eye and bare skin from exposure to harmful UV or optical radiation. Follow the instructions for correct placement of the equipment and the precautions for securing the area before initiating equipment operation.

b) DO NOT TAMPER WITH, MODIFY OR DISABLE ANY SAFEGUARD OR OPERATIONAL FEATURE OF THIS DEVICE. STOP USING THIS DEVICE AND CONTACT THE MANUFACTURER IF YOU SUSPECT THAT IT IS NOT FUNCTIONING PROPERLY.

c) To reduce the risk of injury, close supervision is necessary when this device is used near children.

d) When replacing lamps or UV sources, disconnect power and replace only with the lamps for which the equipment is marked and intended.

Note: Item (d) applies only to equipment with user-replaceable lamps.

e) The use of accessory equipment not recommended by the manufacturer may cause an unsafe condition.

f) Do not use this equipment for other than intended use.

SAVE THESE INSTRUCTIONS

32 Additional Markings and Instructions

32.1 The instruction manual shall include instructions for operation and maintenance recommended by the manufacturer. The instructions shall state that the device does not have any user-serviceable parts (except lamps and filters) and that all servicing should be performed by qualified service personnel.

32.2 The instructions shall include the manufacturer’s declarations for:

a) UV source (lamp) replacement procedure, for equipment with user replaceable sources; and

b) Air filter removal, cleaning and replacement procedure, for equipment with user serviceable filters.

32.3 Equipment shall be permanently and legibly marked with the following product markings on an exterior surface that is normally visible, using a minimum letter height of 2.4 mm:

a) “This equipment produces potentially hazardous UV energy. Refer to the operating manual for important safety and operating instructions.”

32.4 Permanent marking methods include paint-stenciling, indelible ink or die stamping, etching, engraving, embossing, molding, casting, or the use of a suitable marking and labeling system compliant with CSA No. 0.15 / UL 969.

32.5 When required by 29.2(a), the instruction manual shall:

a) Provide instructions to alert the responsible parties to verify safe ozone concentrations in the installation, taking into account the number of products in a given volume of space, the characteristics of the ventilation system, access, and other factors; and

b) Include the following instruction verbatim using a minimum letter height of 2.4 mm: “DO NOT INSTALL THIS EQUIPMENT IN A DWELLING”.

32.6 Equipment with non-user serviceable UV sources shall be permanently and legibly marked with the following product markings on an exterior surface that is normally visible, using a minimum letter height of 2.4 mm:

a) “CAUTION – RISK OF PERSONAL INJURY. The UV source is not user-replaceable. Servicing by qualified personnel only.”

ANNEX A – SAFETY MARKING TRANSLATIONS

(Normative for Canada and Informative for the U.S.)

This Annex includes the markings required to be translated and suggested French translations. For Canada, this Annex is a normative (mandatory) part of this Standard. For the US, this Annex is an informative (non-mandatory) part of the Standard.

Table A.1 Markings
French translations

English Marking Content	French Marking Content	Text	Format	Reference
CAUTION – RISK OF PERSONAL INJURY	ATTENTION – RISQUE DE BLESSURE	Verbatim	S24-L1	21.4
THIS EQUIPMENT IS DESIGNED FOR USE WITH GERMICIDAL LAMPS OR UV SOURCES AND MUST BE INSTALLED IN COMPLIANCE WITH COMPETENT TECHNICAL DIRECTIONS TO PREVENT THE USER'S EYE AND BARE SKIN FROM EXPOSURE TO HARMFUL UV OR OPTICAL RADIATION	CET ÉQUIPEMENT EST CONÇU POUR ÊTRE UTILISÉ AVEC DES LAMPES GERMICIDES OU DES SOURCES UV ET DOIT ÊTRE INSTALLÉ CONFORMÉMENT AUX DIRECTIVES TECHNIQUES APPROPRIÉES POUR EMPÊCHER L'EXPOSITION DES YEUX ET DE LA PEAU NUE DE L'UTILISATEUR À DES RAYONS UV OU DES RAYONNEMENTS OPTIQUES	Verbatim	S24-L1	21.4
DO NOT INSTALL THIS EQUIPMENT IN A DWELLING	N'INSTALLEZ PAS CET ÉQUIPEMENT DANS UNE HABITATION	Verbatim	S24-L2	21.4
CAUTION – RISK OF PERSONAL INJURY	ATTENTION – RISQUE DE BLESSURE	Verbatim	S24-L1	21.5
EYE INJURY MAY RESULT FROM DIRECTLY VIEWING THE LIGHT PRODUCED BY THE LAMP IN THIS EQUIPMENT. ALWAYS TURN OFF LAMP BEFORE SERVICING.	LA LUMIÈRE PRODUITE PAR LA LAMPE DE CET ÉQUIPEMENT PEUT PROVOQUER DES LÉSIONS OCULAIRES. TOUJOURS ÉTEINDRE LA LAMPE AVANT L'ENTRETIEN.	Verbatim	S16-L1	21.5
USE ONLY _____ LAMPS	UTILISEZ UNIQUEMENT _____ LAMPES		S16-L1	21.6
CAUTION – RISK OF PERSONAL INJURY. AN ULTRAVIOLET (UV) GERMICIDAL SYSTEM IS INSTALLED IN THIS AREA. TO PREVENT UV OVEREXPOSURE, DO NOT ENTER THIS ROOM WHEN THE SYSTEM IS IN OPERATION.	ATTENTION – RISQUE DE BLESSURE CORPORELLE. UN SYSTÈME GERMICIDE ULTRAVIOLET (UV) EST INSTALLÉ DANS CETTE ZONE. POUR ÉVITER LA SUREXPOSITION AUX UV, N'ENTREZ PAS DANS CETTE PIÈCE LORSQUE LE SYSTÈME EST EN FONCTIONNEMENT.			22.1

ANNEX B (Normative) – SAFETY-RELATED ELECTRONIC CIRCUIT (SREC) REQUIREMENTS

B1 Scope

B1.1 These requirements apply to safety-related electronic circuits.

B1.2 These requirements are not intended to serve as the sole basis for evaluating risk. End-product requirements may amend or supersede these requirements, as appropriate.

B2 Glossary

B2.1 The following definitions apply to terms used within this annex:

B2.2 CRITICAL CONTROL FUNCTION – A function performed by a discrete component or a component network whose primary purpose is normal operation of the product, but whose failure could cause the device to exceed the electrical, thermal or exposure limits for normal operation as defined in this standard and the additional safety standards that apply to the product; see 1.7. An example would be a function that controls the on-state or maintains the duty cycle of a UV source, where a circuit fault causes the source to unexpectedly energize or to emit higher doses of UV that is permissible.

B2.3 CRITICAL FAILURE (MODE) – A software or hardware fault which can result in a risk.

B2.4 PRODUCT – The device into which the safety-related electronic circuit is integrated.

B2.5 PROGRAMMABLE COMPONENT – Any microelectronic hardware that can be programmed in the design center, the factory, or in the field. For the purpose of this standard, the term “programmable” is considered any manner in which one can alter the software wherein the behavior of the component can be altered. This includes discrete components (e.g., microcontrollers, memory storage ICs) that store or execute software instructions in response to thermal or electrical conditions.

B2.6 PROTECTIVE COMPONENT – A discrete component or component network that has been separately evaluated to reliably perform a protective function. Examples of such components include thermal protectors evaluated to UL 60730-2-9 and fuses evaluated to the UL 248, series of standards.

B2.7 PROTECTIVE FUNCTION – A function performed by a discrete component or component network relied upon to reduce risk during abnormal operating conditions. Examples include functions that:

a) Limit or reduce power in response to elevated ambient conditions or discrete component failures, analogous to the function of a thermal protector in recessed luminaires;

b) Disconnect power in response to the opening of a service compartment access panel, analogous to the function of a mechanical interlock switch to prevent contact with a hot surface or high voltage circuit during maintenance;

c) Limit or reduce available voltage or current at accessible terminals during routine maintenance, such as at the pins of a lamp or lamp holder during lamp replacement;

d) Maintain electrical outputs within limits defined as non-hazardous during abnormal operation, such as those defined for Class 2 or low-voltage limited-energy (LVLE) power sources; and

e) Ensure that the output from a UV source is maintained to within permissible limits.

B2.8 RISK – The unacceptable potential for fire, electric shock, or injury to persons as defined by the product standard of the device being evaluated.

B2.9 SAFETY-RELATED SOFTWARE – Computer programs, procedures, and data resident on the hardware or remotely interactive with the hardware pertaining to the operation of a programmable component that provides safety-related elementary functionality as follows:

a) Exercises direct control over the state of microelectronic or product hardware. When not performed, performed out of sequence, or performed incorrectly, such programs, procedures, and data are capable of resulting in a risk.

b) Monitors the state of microelectronic or product hardware. When not performed, performed out of sequence, or performed incorrectly, such programs, procedures, and data provide data that is capable of resulting in a risk.

c) Exercises direct control over the state of the microelectronic or product hardware. When not performed, performed out of sequence, or performed incorrectly, such programs, procedures, and data are capable of, in conjunction with other human actions, product hardware or environmental failure, resulting in a risk.

B2.10 SAFETY-RELATED ELECTRONIC CIRCUIT – An electronic circuit that implements one or more control or protective functions. These circuits may incorporate any combination of active, passive, programmable, and protective components or semiconductors.

B3 General

B3.1 To ensure an acceptable level of circuit redundancy or supervision, safety-related electronic circuits (SREC) shall be subject to the reliability evaluation in Section B4, Reliability Evaluation.

Exception: SRECs that comply with B3.2 and B3.3 are exempt from this requirement.

B3.2 A design review of the SREC shall be conducted to determine if all the conditions below are true.

a) All critical failure modes that can occur in the SREC hardware due to any discrete component or integrated circuit fault can be identified, simulated and applied via a suitable FMEA or other circuit analysis methods (complexity of the circuit); and

b) All critical failure modes that can occur in the SREC due to a software fault or defect that affect the critical control function or protective function of the SREC can be identified, simulated and applied to determine if the software is relied upon for a critical control function or protective function to work properly. This assessment does not require an analysis of the software itself; rather this is an analysis of all critical failure modes of the SREC due to software faults (complexity of the circuit and software).

B3.3 If the design review in B3.2 indicates that all of the conditions are true, then all product tests shall be conducted using special samples with each of the critical failure modes identified in B3.2 applied, in turn, in the manner likely to result in the most adverse operating condition for each test.

a) The single component faults or simulated software faults (critical failure modes) applied to either a critical control function or protective function shall not lead to unacceptable test results (e.g. temperatures above permissible limits, voltage, current or power levels above permissible limits at a Class 2 output etc.) or create a risk during any applicable test specified in the end-product standard.

b) When the product test is an abnormal condition test, this SREC fault is in addition to the component faults or abnormal conditions required by the test.

c) The product under test is not required to function normally during these tests provided there is no risk.

d) Testing will require consideration for several critical failure modes and the fault type may differ from test to test. To manage the total number of test conditions, based on the design review, tests that will represent the most onerous conditions can be selected.

B4 Reliability Evaluation

B4.1 Safety-related electronic circuits shall be evaluated to the requirements of the UL 60730-1; including Annex H: Requirements for Electronic Controls. Safety-related electronic circuits that do not rely on safety-related software are not required to comply with H.11.12.

B4.2 When a product contains a safety-related electronic circuit intended to provide the function of thermal protection in recessed equipment, it shall additionally comply with UL 60730-2-9.

B4.3 With reference to B4.1, and unless specifically superseded by a relevant Part 2 standard, the following parameters from Annex H in UL 60730-1 apply:

a) Safety-related software shall be evaluated as Software Class B.

b) The Thermal Cycling test shall be performed using the ambient operating temperature range designated by the manufacturer or the temperature parameters below, whichever are more severe:

1) The lower parameter shall be -35 °C (-31 °F) for wet location products, 0 °C (32 °F) for damp location products, and 10 °C (50 °F) for all other products; and

2) The upper parameter shall be 40 °C (104 °F).

c) When evaluating for compliance with the EMC requirements – Immunity:

1) Protective circuits are considered Type 2 protective controls; and

2) Critical control circuits are considered Type 2 operating controls.

d) The Test of Influence of Voltage Unbalance is not applicable.

e) For the Ring Wave test, Overvoltage Category III shall be used.

f) The Test of Influence of Supply Frequency Variations is not applicable if the safety-related electronic circuit does not rely on the power line frequency for timing or control.

g) The Power Frequency Magnetic Field Immunity Test is not applicable if the safety-related electronic circuit does not rely on Hall-effect devices, such as current-sensing transformers.

B4.4 With regard to the Evaluation of Compliance in Annex H:

a) The requirements in the product standard applicable to creepage, clearance and dielectric voltage withstand shall be used when they are more severe; and

b) As a result of each test, the product incorporating the safety-related electronic circuit shall not exhibit a risk and either:

1) Continue to function as intended with no degradation to the critical control or protective functions (i.e., normal performance with no loss of protective functions);

2) Cease to function, with normal function restored by an automatic, user-resettable or user-replaceable protective component or function such as an automatic or manual-reset protector, a fuse replacement, or cycling the power to the product (i.e., loss of protective function with safety shut down); or

3) Cease to function permanently.

ANNEX C (Normative) – SIZE AND LOCATION DESIGNATIONS FOR MARKINGS

Table C.1
Format – Minimum size designation for marking height and typeface

Size designation	Letter height		Font size (points)	Font typeface uppercase
	mm	(in)		
S16	1.6	(0.062)	6	Universal bold, Arial bold, Helvetica bold, Zurich BT Bold
S24	2.4	(0.094)	10	Universal bold, Arial bold, Helvetica bold, Zurich BT Bold

Table C.2
Format – Location designation for marking

Location designation	Description	Label exposed to a dry/damp environment	Label exposed to a wet environment
L1	Visible during relamping, and after installation	Type P	Type P
L2	Visible during installation	Type N	Type P
L3	Visible during installation and inspection of wire connections, located near the supply connections	Type N	Type P
L4	On the smallest unit package or carton	Type T	Type T
L5	On an instruction sheet or tag	Type T	Type T

Type P designates a permanent label or nameplate that is intended to remain in the applied position for the lifetime of the luminaire under conditions of normal use. It provides information required for user maintenance over the expected life of the product. It is made of metal, plastic, or printed on a suitable pressure-sensitive label that complies with UL 969.

Type N designates a non-permanent label or nameplate that is intended to remain in place only for the purpose of installation. It shows the certification mark, manufacturer's identification, and product identification. It is made of paper with an adhesive backing.

Type T designates a temporary label, instruction sheet, or tag that is not required after installation. It provides installation instructions, and information not required after installation. It is made of printed matter with or without adhesive and/or attachment, and is intended to be included with, or attached to, the product.

ANNEX D (Normative) – MOTION DETECTORS

Determination of Coverage Area

D1 Scope

D1.1 The test procedures in this Annex determine the coverage area of an integral motion detector or system, when it is relied on as a safeguard to mitigate the risk of UV overexposure.

D1.2 These requirements are predicated on the assumption that the space being treated was vacated prior to UV equipment operation, and that a person attempts to re-enter the space while the equipment is operating.

D1.3 Presence detection is outside the scope of this annex.

D2 Glossary

D2.1 The definitions below apply to terms used in this Annex.

D2.2 CELL – A 0.91 m by 0.91 m (3 feet by 3 feet) section of the grid.

D2.3 COVERAGE AREA – The area in which the motion detector can detect motion, as determined by the test procedures in this Annex.

D2.4 GRID – The floor area in which the detector is tested divided into cell sections.

D2.5 Horizontal Field Of View (HFOV) – The area of coverage in a horizontal plane to the motion detector.

D2.6 MICROWAVE – Type of motion detector that emits a low power microwave into the area being monitored. Changes in the reflection pattern caused by motion are received by the detector and converted into an electrical signal.

D2.7 MOTION DETECTOR – The integral control employed to detect motion. This control can be implemented using a single detector or with a system of multiple detectors. The detectors can consist of one or a combination of various sensing technologies (e.g., passive infrared, ultrasonic, microwave).

D2.8 PASSIVE INFRARED – Type of motion detector that uses thermal detectors to absorb the received energy focused on them. A change in energy received by a thermal detector results in a change in detector temperature which results in an electrical signal. When a person moves into or out of a field of view, the detector experiences a change in received energy, which is converted into an electrical signal.

D2.9 SENSITIVITY – The ability of the motion detector to detect the designated magnitude of motion for a given application.

D2.10 ULTRASONIC – Type of occupancy motion detector that emits a low power sound into the area being monitored. The sound wave is at a frequency above the range that a person can hear. Changes in the reflection pattern caused by motion are received by the motion detector and converted into an electrical signal.

D2.11 VERTICAL FIELD OF VIEW (VFOV)– The area of coverage in a vertical plane to the motion detector.

D3 Determination of Coverage Area

D3.1 Test environment

D3.1.1 The test room where the motion detector will be investigated shall have the following characteristics:

a) The room shall be larger than the manufacturer's specified coverage area in length and width by at least 5 %, and have a ceiling height of at least 2.75 m (9 feet), so that the test subject can walk into the field of view of the motion detector from outside of its coverage area during testing.

Alternatively, when the manufacturer's specified coverage area exceeds any of the dimensions (length, width or height) of the test room, one half of the field of view can be tested, followed by re-positioning the motion detector, for the test to be performed on the other half of the field of view.

Note: The alternate test method is acceptable for (a) line of sight motion detectors; or (b) ultrasonic motion detectors that have opposing transmit and receive ports, such that the FOV can be divided in half. Other types of motion detectors shall be tested with the standard method.

b) The floor shall be visibly divided into a square grid with cell dimensions of 0.91 by 0.91 m (3 feet by 3 feet).

c) During testing, the room's ambient temperature shall be maintained at 25 ±5 °C. The ambient shall be measured at a horizontal distance of 1 ±0.1 m (3.05 ±0.3 feet) from the motion detector, at the motion detector height.

d) During testing, the room's relative humidity shall be between 30 % and 70 %.

D3.2 Test setup

D3.2.1 Prior to testing, the test sample shall be maintained at the test room's ambient temperature and relative humidity for at least 1 hour.

D3.2.2 During testing, the sample shall be supported on a stable and vibration free surface.

D3.2.3 Samples shall be tested in the orientation that simulates their intended use condition:

a) Motion detectors intended for mounting on walls shall be secured to a mounting surface perpendicular to the test room floor;

b) Motion detectors intended for mounting on ceilings shall be secured to a mounting surface parallel to the test room floor; and

c) Motion detectors intended for mounting on walls and ceilings shall be tested as specified in D3.2.3(a) and D3.2.3(b), in turn.

D3.2.4 The sample shall be set up and tested in accordance with the manufacturer's recommendations, in turn, as follows:

a) Mounted in its intended operating orientation (see D3.2.3) at the minimum height from the floor declared by the manufacturer; and

b) Mounted in its intended operating orientation (see D3.2.3) at the maximum height from the floor declared by the manufacturer.

NOTE: Motion detectors intended for both wall and ceiling mounting will have 4 test parameters (wall-minimum, wall-maximum, ceiling-minimum and ceiling-maximum).

D3.2.5 When the motion detectors have adjustable positioning, they shall be adjusted in the most adverse position or positions allowed by their construction for each test. Several iterations of the testing