UL 62841-3-1000

STANDARD FOR SAFETY

Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1000: Particular Requirements For Transportable Laser Engravers

UL Standard for Safety for Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1000: Particular Requirements For Transportable Laser Engravers, UL 62841-3-1000

First Edition, Dated December 31, 2019

SUMMARY OF TOPICS

This is the First Edition of ANSI/UL 62841-3-1000, the Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1000: Particular Requirements For Transportable Laser Engravers. The standard provides construction, performance, and marking and instruction requirements for the evaluation of transportable CO_2 laser engravers with a laser power not exceeding 60 watts intended to cut, incise a design, engrave, ablate, burn, color, and perform similar processes on material samples inserted into the equipment.

The new requirements are substantially in accordance with Proposal(s) on this subject dated July 12, 2019 and October 18, 2019.

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Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1000: Particular Requirements For Transportable Laser Engravers

First Edition

December 31, 2019

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

The most recent designation of ANSI/UL 62841-3-1000 as an American National Standard (ANSI) occurred on December 13, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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Annexes

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Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1000: Particular Requirements For Transportable Laser Engravers

This standard is to be used in conjunction with the First edition of UL 62841-1.

This standard, where stated, amends the requirements of UL 62841-1. Where a particular subclause of UL 62841-1 is not mentioned in UL 62841-3-1000, the UL 62841-1 subclause applies.

1 Scope

This clause of Part 1 is applicable, except as follows:

Addition:

This part of UL 62841 applies to transportable CO_2 **laser engravers** with a laser power not exceeding 60 watts intended to cut, incise a design, engrave, ablate, burn, color, and perform similar processes on material samples inserted into the equipment.

This standard does not apply to fiber **laser engravers** and **laser engravers** intended for industrial use.

2 Normative references

This clause of Part 1 is applicable, except as follows:

Addition:

IEC 60695-11-20:1999, *Fire hazard testing – Part 11-20: Test flames 500 W flame test methods*

(CFR) Title 21, Part 1040, *US Code of Federal Regulations*

3 Terms and definitions

This clause of Part 1 is applicable, except as follows:

3.101 **air assist:** a constant stream of compressed air across the engraving or cutting surface at the point of burn to remove heat and combustible gases from the surface of the material and helps prevent the formation of flames.

3.102 **exhaust system:** a method of removing laser out-gas fumes and odours by a ventilation system connected to the **laser engraver**

3.103 **laser engraver:** tool employing a high intensity beam of light that is intended to cut, incise a design, engrave, ablate, burn, color, and perform similar processes on a variety of material inserted into the equipment.

4 General requirements

This clause of UL 62841-1 is applicable.

5 General conditions for the tests

This clause of UL 62841-1 is applicable, except as follows:

5.17 *Addition:*

*The mass of the **laser engraver** shall include any additional parts such as leg sets or carrying means that are required in accordance with the user instructions.*

6 Radiation, toxicity and similar hazards

This clause of UL 62841-1 is applicable, except as follows:

6.101 Laser

The tool employing a laser intended to cut, incise a design, engrave, ablate, burn, color, and perform similar processes on a variety of material inserted into the equipment shall comply with Code of Federal Regulations (CFR), Title 21, Part 1040.

7 Classification

This clause of UL 62841-1 is applicable.

8 Marking and instructions

This clause of UL 62841-1 is applicable, except as follows:

8.2 *Addition:*

Laser engravers shall be marked with safety information which shall be written in English or marked with the appropriate symbol.

For all **laser engravers**:

" ⚠ WARNING – Fire hazard. Never operate the laser system unattended. Combustible materials exposed to the laser beam may ignite."

" ⚠ WARNING – Do not operate the machine without proper operating exhaust system."

The WARNING markings shall be readily visible to the user and shall not be located on the underside of the machine.

8.14.1.1 *Replacement:*

8.14.1.1 **General safety warnings**

NOTE The term "**laser engraver**" can be substituted by "laser cutter" in the safety warnings.

⚠ **WARNING Read all safety warnings, instructions, illustrations and specifications provided with this laser engraver.** *Failure to follow all instructions listed below may result in electric shock, fire and/or serious injury.*

Save all warnings and instructions for future reference.

1) **Work area safety**

a) **Keep work area clean and well lit.** *Cluttered or dark areas invite accidents.*

b) **Do not operate laser engraver in explosive atmospheres, such as in the presence of flammable liquids, gases or dust.** *Laser beam may ignite the dust or fumes.*

c) **Set up and operate the laser engraver in a well-ventilated area. Place laser engraver on flat nonflammable surface and away from flammable material. Provide at least 8 inches of unobstructed spacing around laser engraver to allow ventilation.** *Laser engravers may create fumes that irritate eyes and airways. Obstructing airflow into or out of laser engraver may result in serious personal injury.*

d) **Always use a properly configured, installed, maintained, and operating fume/smoke exhaust system as recommended by the manufacturer when operating the laser engraver.** *Caustic fumes and smoke from the cutting and engraving process must be extracted from the laser system and exhausted outside or properly filtered to reduce the risk of personal injury.*

e) **Always keep a properly maintained and inspected fire extinguisher in the area.** *Typically, Carbon Dioxide (CO_2) chemical fire extinguishers should be used.*

f) **Laser engravers must be operated only by persons familiar with their operation and manufacturer's instructions.** *Operation of laser cutters by persons unfamiliar with their operation and manufacturer's instructions can result in electric shock, fire and/or serious injury.*

g) **Do not allow unsupervised children and bystanders to interact with the laser engraver while it is operating.** *Persons unfamiliar with the operation of the laser engraver may change its setup, which may increase the risk of electric shock, fire and/or serious injury.*

2) **Electrical safety**

a) **Laser engraver plugs must match the outlet. Never modify the plug in any way. Do not use any adapter plugs with earthed (grounded) laser engravers.** *Unmodified plugs and matching outlets will reduce risk of electric shock.*

b) **While operating the laser engraver, avoid body contact with earthed or grounded surfaces such as pipes, radiators, ranges and refrigerators.** *There is an increased risk of electric shock if your body is earthed or grounded.*

c) **Do not expose laser engravers to rain or wet conditions.** *Water entering a laser engraver may increase the risk of electric shock.*

d) **Before every operation of a water-cooled laser engraver, make sure that the coolant connections and laser tube are leak-free.** *Water leaks may increase the risk of electric shock.*

e) **Do not abuse the cord. Never use the cord for carrying, pulling or unplugging the laser engraver. Keep cord away from heat, oil, sharp edges or moving parts.** *Damaged or entangled cords increase the risk of electric shock.*

f) **Do not operate laser engravers in damp locations.** *Use of laser engravers in damp locations may increase the risk of electric shock.*

3) **Personal safety**

a) **Stay alert, watch what you are doing and use common sense when operating a laser engraver. Do not use laser engraver while you are tired or under the influence of drugs,**

alcohol or medication. *A moment of inattention while operating laser engravers may result in serious personal injury.*

b) **Use personal protective equipment. Always wear eye protection appropriate for class of laser engraver.** *Protective equipment such as heat and cut resistant gloves used when work pieces are hot or have sharp edges will reduce personal injuries.*

c) **Dress properly. Do not wear loose clothing or jewelry. Keep your hair, clothing and gloves away from moving parts.** *Loose clothes, jewelry or long hair can be caught in moving parts.*

d) **Be careful removing work pieces from the laser cutter. Cutting with a laser increases the temperature of the work piece and the temperature of the work piece may remain high after laser cutter stops operating.***Touching hot work pieces before they cool down may result in burns.*

e) **Do not let familiarity gained from frequent use of laser engravers allow you to become complacent and ignore laser engraver safety principles.** *A careless action can cause severe injury within a fraction of a second.*

4) **Laser engraver use and care**

a) **Prevent idle laser engraver from being used by children and do not allow persons unfamiliar with the laser engraver or these instructions to operate the laser engraver.** *Laser engravers can be dangerous in the hands of untrained users.*

b) **Maintain laser engravers. Check for misalignment or binding of moving parts, breakage of parts, coolant leaks and any other condition that may affect the laser engraver's operation. If damaged, have the laser engraver repaired before use.** *A poorly maintained laser engraver may result in a risk of shock, fire and/or serious injury.*

c) **Use the laser engraver in accordance with these instructions, taking into account the working conditions and the work to be performed.** *Use of the laser engraver for operations different from those intended could result in a hazardous situation.*

5) **Service**

a) **Have your laser engraver serviced by a qualified repair person using only identical replacement parts.** *This will ensure that the safety of the laser engraver is maintained.*

8.14.1 *Addition:*

The additional safety instructions as specified in Clause 8.14.1.101 shall be given. This part may be printed separately from the "General Power Tool Safety Warnings".

8.14.1.101 **Safety instructions for laser engravers**

Laser engraver safety warnings:

a) ⚠ **WARNING: Never expose yourself to the laser beam since it may cause physical burns and can cause severe eye damage.** *Proper use and care of this laser engraver system are essential to safe operation.*

b) **Never operate the laser engraver system without constant supervision of the cutting and engraving process.** *Exposure to the laser beam may cause ignition of combustible materials and start a fire.*

c) **Never use PVC or other nonconductive duct materials for the exhaust system.** *Static charges may build up and may cause a risk of fire or explosion.*

d) **Always use fire rated rigid or flexible metal or metalized ducting in the exhaust system.** *Non-fire rated exhaust ducting may increase the risk of fire.*

e) **Always inspect the exhaust fan and duct work for obstructions and ensure proper air flow exists before each use.** *Unobstructed and properly maintained exhaust fan and duct work will reduce the risk of fire and effectively extract caustic fumes and smoke.*

f) **Never engrave or cut any unknown material. Only engrave materials recommended by the manufacturer. The vaporization/melting of many materials, including but not limited to PVC and polycarbonates, can give off hazardous fumes.** *Always refer to the Safety Data Sheet (SDS) from the material manufacturer to determine the response of any work material to extreme heat (burning/fire hazard) to prevent hazards.*

g) **Always use the air assist as recommended by the manufacturer, especially while cutting. Cutting movements are relatively slow and apply an extremely large amount of heat to the work piece.** *Avoid the build-up of heat in order to reduce the risk of fire.*

h) **Keep the interior of the laser cutter, including the table tray, clean and free of debris. Clean the laser.** *A build-up of cutting and engraving residue and debris is dangerous and may increase the risk of fire.*

i) **Never look into the beam of the alignment laser.** *Eye injury may result.*

j) **Never operate the alignment laser without the focus lens or other optical elements of laser engraver in place.** *The unfocused beam may be reflected out of the chassis and increase the risk of eye injury.*

k) **Do not operate the laser machine with any of the panels removed. Remember that the laser beam is invisible!** *Exposure of the laser beam will greatly increase the risk of injury and/or fire.*

l) **Before using the laser machine, test the residual current device (RCD) provided with the supply cord to insure it is operating correctly.** *A properly operating RCD reduces the risk of electrical shock.*

NOTE 101 The term "residual current device (RCD)" may be replaced with the term "ground fault circuit interrupter (GFCI)" or "earth leakage circuit breaker (ELCB)".

NOTE 102 The above warning is omitted for lasers that are not cooled with water.

m) **Do not attempt to modify or defeat the safety interlock system for any reason.** *This could result in exposure to hazardous laser radiation.*

n) **Do not use laser engraver with extension cords.** *The RCD on the machine power cord will not prevent electrical shock from the extension cords.*

NOTE 101 The term "residual current device (RCD)" may be replaced with the term "ground fault circuit interrupter (GFCI)" or "earth leakage circuit breaker (ELCB)".

NOTE 102 The above warning is omitted for lasers that are not cooled with water.

8.14.2 a) *Addition:*

101) Instruction on air flow and pressure needed in configuring the **exhaust system** and how to properly set up **exhaust system** using rigid or flexible metal or metalized ducting to prevent collapsing;

102) Instruction not to use PVC or other nonconductive duct materials for the **exhaust system** including proper earthing of the metal duct system to dissipate static electricity.

103) Instruction on how to inspect and clean or replace the **exhaust system**.

104) If applicable, instruction on how to set up and install a cooling system for the laser tube;

8.14.2 b) *Addition:*

101) Instruction on when to wear suitable laser safety protection glasses;

102) Instruction about materials that should not be laser cut (e. g. carbon, chlorinated plastics, polycarbonate, polyvinyl chloride (PVC), ABS, HDPE, polystyrene foam, polypropylene foam, beryllium oxide and materials containing halogens (fluorine, chlorine, bromine, iodine and astatine), epoxy-based or phenolic resins, fiberglass, coated carbon fibre, pressure treated wood, galvanized metal, mirrored or reflective surfaces);

8.14.2 c) *Addition:*

101) Instruction on how to properly clean the **laser engraver** and the optical laser system;

102) Instruction on how to align laser mirrors.

9 Protection against access to live parts

This clause of UL 62841-1 is applicable.

10 Starting

This clause of UL 62841-1 is applicable.

11 Input and current

This clause of UL 62841-1 is applicable.

12 Heating

This clause of UL 62841-1 is applicable, except as follows.

12.2.1 *Replacement:*

The **laser engraver** is operated for a duration corresponding to the most unfavorable conditions of **normal use**.

NOTE The duration of the test may consist of more than one cycle of operation.

13 Resistance to heat and fire

This clause of UL 62841-1 is applicable, except as follows:

13.2 Replacement of the third paragraph:

Compliance is checked by the following:

– the enclosure material is classified at least 5V according to IEC 60695-11-20:1999 provided that the test sample was no thicker than the relevant part;

13.101 Fire containment

13.101.1 **Laser engraver** enclosures shall contain the spread of fire.

Compliance is checked by the following test.

*The test shall be conducted in a closed, draft-free room. When mechanical ventilation is employed during the test, an air stream shall not be directed across the **laser engraver**. The test room shall have:*

– vents for the discharge of the combustion products; and

– provisions for fresh air intake so that no oxygen-deficient air is introduced into the test configuration during the test.

*The **laser engraver** shall be placed on a soft wood surface covered by two layers of tissue paper. The sample shall be covered by one layer of untreated 100 % medical gauze panels. The panels shall be held in close contact with the external surfaces of the **laser engraver**. A mechanical means, such as small pieces of metal foil adhesive tape, shall be employed to secure the panels to each other, so that there are no gaps between the panels. The tape shall not cover openings or enclosure seams in the construction of the **laser engraver**. The side, front, and back panels of medical gauze shall be of sufficient length to touch the bottom surface of tissue paper. The air duct fan and **exhaust system** shall be set up and operated during the test in accordance with Clause 8.14.2 a) 101.*

*A test fuel load shall be configured to represent 60% of the working surface of the **laser engraver** tray. The fuel load shall consist of 4 sheets of polypropylene containing no flame retardants, each 1.59 ±0.05 mm thick, stacked evenly with flush edges on top of each other.*

A perforated metal sheet shall be positioned with standoffs in the four corners such that the top of the fuel load is aligned with the highest possible cutting/engraving surface table of the device as shown in Figure 101. The perforated metal sheet shall be made of 1.3 ±0.1 mm thick steel sheet perforated with 4.0 ±0.1 mm holes in a staggered pattern resulting in 46% open surface area.

*The fuel load shall be centrally configured on the perforated metal sheet and the crucible shall be positioned flush with the top surface of the perforated metal sheet. The height of the fuel load, indicated by H in Figure 101, shall be positioned such that the top of the fuel load is located at the maximum capacity of the **laser engraver**. The crucible shall be a steel cup with a volume of 30 mL and nominal diameter of 36 mm modified to be 22.2 ±0.1 mm high. The crucible shall be centrally located under the corner of the fuel load (polypropylene sheets). See Figure 102. The corner selected for placement of the crucible shall be chosen to produce the worst case results. (e.g. opposite side of any heat sensors). The portion of the metal sheet interfering with the crucible placement shall be removed to prevent any obstruction of the ignition source, as shown in Figure 102. The **laser engraver** tray provided with the **laser engraver** shall be placed at its lowest possible setting during the test.*

The air duct fan system shall be turned on and the crucible shall be filled with 10 ±0.5 mL of isopropyl alcohol just prior to beginning the test.

The isopropyl alcohol in the crucible is ignited and any access door(s) or panels shall be immediately closed for the duration of the test.

The test shall be conducted until the gauze or tissue paper ignites, or until there are no glowing particles, or if neither of these occurs, until at least 7 h has elapsed.

No charring or burning of the gauze or tissue paper shall result. Charring is defined as a blackening of the gauze caused by combustion. Discoloration of the gauze caused by smoke is acceptable.

Protection against electric shock as specified in Clause 9 shall be maintained.

Protection against accessibility to moving parts as specified in Clause 19.1 shall be maintained, if the test resulted in new openings being created in the enclosure.

14 Moisture resistance

This clause of UL 62841-1 is applicable, except as follows:

14.101 Polymeric fluid-handling components

A **laser engraver** that employs a polymeric fluid-handling component (PFHC), such as a reservoir, tank, or tubing, shall not subject the user to an increased risk of electrical shock.

Compliance is checked by the following test:

The residual current device shall be disabled during the test. Electrical components, covers and other parts which can be removed without the aid of a tool are removed, except those fulfilling the test of Clause 21.22.

*The **laser engraver** is prepared with approximately 1,0 % NaCl solution and set up as described in 8.14.2;*

A 6.4-mm diameter hole shall be drilled in the PFHC in any location that can result in the solution reaching a live part, film-coated wire, or insulation. If the inside diameter of the tubing is less than 6.4 mm, the size of the hole drilled in the tubing shall be equal to the inside diameter of the tubing.

*The **laser engraver** is operated at **rated voltage** and operated as in **normal use** according to 8.14.2 b) for 1 min while monitoring the leakage current as in Clause C.3. During the test the leakage current shall not exceed:*

- *2 mA for a **CLASS II TOOL**;*
- *5 mA for a **CLASS I TOOL**.*

*Immediately after the appropriate treatment, the **laser engraver** shall withstand the electric strength test of Clause D.2 between live parts and accessible parts and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances and clearances below the values specified in Clause 28.1.*

15 Resistance to rusting

This clause of Part 1 is applicable.

16 Overload protection of transformers and associated circuits

This clause of UL 62841-1 is applicable.

17 Endurance

This clause of UL 62841-1 is applicable.

18 Abnormal operation

This clause of UL 62841-1 is applicable, except as follows:

18.8 *Modification:*

Table 4
Required performance levels

Type and purpose of SCF	Minimum Performance Level (PL)
Power switch – prevent unwanted switch-on	Shall be evaluated using the fault conditions of 18.6.1 without the loss of this SCF
Power switch – provide desired switch-off	Shall be evaluated using the fault conditions of 18.6.1 without the loss of this SCF
Restart prevention in accordance with 21.18.2.1	b
Lock-off function as required by 21.18.2.3	b
Prevent exceeding thermal limits as in Clause 18	a
Laser Interlock (Open lid switch) – provide desired switch-off of laser	Shall be evaluated using the fault conditions of 18.6.1 without the loss of this SCF
Laser Interlock (Close lid switch) – prevent inadvertent switch-on of laser	Shall be evaluated using the fault conditions of 18.6.1 without the loss of this SCF
Loss of Laser Cooling (Water Flow System - unless it can be shown by test that failure of water supply would not increase risk of fire or injury to persons) as required in Clause 19.102	b
Loss of **Air Assist** (Flow Meter System) as in Clause 19.101	b
Loss of external air exhaust fan	b

19 Mechanical hazards

This clause of UL 62841-1 is applicable, except as follows.

19.1 *Addition:*

The requirements of Clause 19.1 do not apply to those guards covered by Clause 19.1.101.

19.1.101 The laser cutting system shall be guarded.

Access cover(s) that have to be opened to align or change the work piece in accordance with Clause 8.14.2 shall remain attached to the laser machine. There shall be no access to hazardous moving parts and the laser cutting/engraving beam shall not operate while the access cover is opened. Two independent interlocks shall be employed and located minimum 300 mm apart from each other. Such interlocks switches shall be classified with respect to endurance for 50 000 operating cycles in accordance with Clause 23.1.10.1.

Compliance is checked by inspection and measurement.

19.3 *Replacement:*

It shall not be possible to reach dangerous moving parts and the laser cutting system beam through exhaust openings with the detachable part or provisions for exhaust removed.

Compliance is checked by applying a test probe B of IEC 61032:1997 with a force not exceeding 5 N.

19.4 This subclause of UL 62841-1 is not applicable.

19.6 This subclause of UL 62841-1 is not applicable.

19.101 **Air Assist**

To guard against formation of flames during cutting and engraving operations, an **air assist** system shall be provided. The laser system beam shall cease to operate upon loss of the **air assist** system.

Compliance is checked by inspection.

19.101.1 **Laser cooling system**

The CO_2 laser tube shall be provided with a cooling system. The laser beam shall cease to operate upon loss of operation of the laser cooling system unless it can be shown by test that failure of the cooling system would not increase risk of fire or injury to persons as required in Clause 19.102.

Compliance is checked by inspection.

19.102 **Laser beam shut off time**

The shut off time of the laser beam shall not exceed 0.25 s after the access cover is opened, and 3 s after switching off the unit, upon loss of the **air assist**, and loss of operation of the laser cooling system.

Compliance is checked by inspection and measurement.

20 Mechanical strength

This clause of UL 62841-1 is applicable, except as follows:

20.5 This subclause of UL 62841-1 is not applicable.

20.101 If a carrying means is provided, the means for transportation of the **laser engraver** shall be of adequate strength to safely transport the **laser engraver**.

Compliance is checked by inspection and the following test.

Carrying means are subjected to a force corresponding to three times the weight of the equipment but not more than 600 N per carrying means. The force is applied in the direction of lifting uniformly over a 70 mm width at the centre of the carrying means. The force is steadily increased so that the test value is attained within 10 s and maintained for a period of 1 min.

If more than one carrying means is provided or if a portion of the weight is distributed over a wheel, the force is distributed between the carrying means in the same proportion as in the normal transportation position. If the equipment is provided with more than one carrying means, but so designed that it may readily be carried by only one carrying means, each carrying means shall be capable of sustaining the total force

The carrying means shall not break loose from the equipment and there shall not be any permanent distortion, cracking or other evidence of failure.

20.102 A working stand, if provided with the **laser engraver** or if specifically identified in accordance with 8.14.2, shall have a locking mechanism to keep the stand in the unfolded upright position and shall have adequate strength.

Compliance is checked by inspection and by the following test.

*The **laser engraver** is mounted to the working stand and an additional force is gradually increased to 750 N and then applied for 1 min, distributed equally on the top of the **laser engraver**. During the test, the working stand shall not collapse, and after removing the force it shall not show any permanent deformation.*

NOTE Equal distribution of the additional force can be achieved by using bags of sand or other similar means.

21 Construction

This clause of UL 62841-1 is applicable, except as follows:

21.18.2.1 *Addition:*

After voltage recovery, following an interruption of the supply, the **laser engraver** shall not automatically restart.

21.30 This clause of UL 62841-1 is not applicable

21.35 *Replacement:*

Laser engravers shall have an integral air exhaust port which allows the mounting of an external suction device for evacuating the by-products of the engraving process. The exhaust collection device(s) shall:

– operate in back or the side of the **laser engraver** and direct the discharge away from the operator; and

– not interfere with the performance and operation of the **laser engraver** mechanism.

*Compliance is checked by inspection with the **exhaust system** ducting or hoses as specified in accordance with 8.14.2 a) attached to the opening, and as specified in the referenced subclauses.*

22 Internal wiring

This clause of UL 62841-1 is applicable.

23 Components

This clause of UL 62841-1 is applicable.

24 Supply connection and external flexible cords

This clause of UL 62841-1 is applicable.