



UL 1815

STANDARD FOR SAFETY

Nonducted Heat Recovery Ventilators

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UL Standard for Safety for Nonducted Heat Recovery Ventilators, UL 1815

Fifth Edition, Dated February 29, 2012

Summary of Topics

This new edition of UL 1815 includes the following changes in requirements:

Addition of requirements when employing polymeric and other nonmetallic materials

Relocation of the component requirements from Appendix A into the body of the standard

The new requirements are substantially in accordance with Proposal(s) on this subject dated July 18, 2011.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

The following table lists the future effective dates with the corresponding item.

Future Effective Date	References
May 14, 2012	Paragraphs 33.2 and 72.1.19, Table 33.1, and Figure 33.1.



FEBRUARY 29, 2012

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UL 1815

Standard for Nonducted Heat Recovery Ventilators

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Fifth Edition

February 29, 2012

This UL Standard for Safety consists of the Fifth Edition.

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 <http://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover nonducted, stationary or fixed heat recovery ventilators for household, commercial, or industrial use and intended to be employed in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements cover heat recovery ventilators rated 600 volts or less.

1.3 These requirements cover heat recovery ventilators that may be mounted through a wall or ceiling, or in a window.

1.4 These requirements cover heat recovery ventilators that may employ short ducts intended to bring air to and from the equipment. These requirements do not cover heat recovery ventilators employing ducts intended to supply conditioned air for environmental heating and/or cooling or distribute air throughout a building; such units are judged under the requirements in the Standard for Ducted Heat Recovery Ventilators, UL 1812. These requirements do not preclude a preheater provided as part of the air exchange system.

2 Undated References

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

3 Units of Measurement

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

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 CONTROL, AUTOMATIC – A control in which at least one aspect is non-manual.

4.3 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

4.4 CONTROL, MANUAL – A device that requires direct human interaction to activate or rest the control.

4.5 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential hazard, is considered an operating control. Operating controls are also referred to as “regulating controls”.

4.6 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as “limiting controls” and “safety controls”.

4.7 CONTROL, TYPE 1 – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this standard.

4.8 CONTROL, TYPE 2 – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this standard.

4.9 DUCT FAN – A straight-through ventilator provided with flanges for connection to a duct and which may be used with heated air.

4.10 ENCLOSURE – That part of a unit which by itself or in conjunction with barriers reduces the risk of contacting all or any parts of the unit that may otherwise present a risk of electric shock or injury to persons and/or prevents propagation of flame initiated by electrical disturbances occurring within.

4.11 FIELD WIRING TERMINAL – A terminal to which a wire may be connected in the field, unless the wire and a means of making the connection – such as a pressure terminal connector, soldering lug, soldered loop, or crimped eyelet – that is factory assembled to the wire are provided as part of the heat recovery ventilator.

4.12 FUNCTIONAL PART – A part other than an enclosure or structural part that is necessary for the intended operation of a unit.

4.13 HEAT RECOVERY VENTILATOR – A product intended to remove air from a building, replace it with air outside the building and in the process transfer heat from the warmer to the colder air.

4.14 MOTORS:

a) Open Motor – A motor having ventilating openings that permit passage of external cooling air over and around the windings of the motor.

b) Totally Enclosed Motor – A motor that is enclosed so as to prevent the free exchange of air between the inside and outside of the case but not sufficiently enclosed to be termed airtight.

c) Totally Enclosed Fan-Cooled Motor – A totally enclosed motor with external cooling by a fan or fans integral with the motor but external to the enclosing parts.

4.15 POWER VENTILATOR – A ventilator that consists of an impeller – which may be of the centrifugal, axial, or propeller type – and an integral driver. A power ventilator is:

a) Installed in a weather-resisting base intended to fit, usually by a curb, over a wall or roof opening, or

b) Provided with flanges for connection to a duct.

4.16 STRUCTURAL PART – A part used in such a manner that failure of the part may present a risk of electric shock or injury to persons.

4.17 USER SERVICING – Any form of servicing, such as routine cleaning, changing a filter or a heat exchange medium, and the like, that might be performed by personnel other than those trained to maintain the appliance.

CONSTRUCTION

5 General

5.1 An appliance shall employ materials that are acceptable for the particular use.

6 Component

6.1 A component of a product covered by this standard shall:

- a) Comply with the requirements for that component;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability;
- d) Additionally comply with the applicable requirements of this end product standard; and
- e) Not contain mercury.

Exception No. 1: 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.*

Exception No. 2: A component complying with a UL component standard other than those cited in this standard is acceptable if:

- a) The component also complies with the applicable component standard; or*
- b) The component standard:*
 - 1) Is compatible with the ampacity and overcurrent protection requirements in the National Electrical Code, NFPA 70, where appropriate;*
 - 2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B; and*

3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.

6.2 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.

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

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

6.4 A component not anticipated by the requirements of this standard and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 6.1 (b) – (d).

6.5 With regard to a component being additionally investigated, reference to construction and performance requirements in another UL end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of this standard.

7 Frame and Enclosure

7.1 General

7.1.1 An appliance shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without resulting in a risk of fire, electrical shock, or injury to persons due to total or partial collapse with a resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.1.2 A cast- or sheet-metal section of the enclosure shall not be thinner than the applicable value specified in Table 7.1.

Exception No. 1: A small area or surface that is curved or otherwise reinforced to provide equivalent mechanical strength need not comply with the specifications in the first column of thicknesses in Table 7.1.

Exception No. 2: A section of the enclosure made of uncoated or galvanized sheet steel or cast malleable iron may be thinner than the specifications in the first column of thicknesses in Table 7.1 if such factors as the following are considered acceptable:

- a) Mechanical strength and impact resistance with regard to intended use and location of the appliance;*
- b) Resistance to corrosion;*
- c) Size and shape; and*

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d) Location on the appliance.

Table 7.1
Minimum acceptable thicknesses of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength, inch (mm)		At surfaces to which a wiring system is to be connected in the field, inch (mm) ^a		At large, unreinforced, flat surfaces, inch (mm)	
Die-cast metal	3/64	(1.2)	—		5/64	(2.0)
Cast malleable iron	1/16	(1.6)	—		3/32	(2.4)
Other cast metal	3/32	(2.4)	—		1/8	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029	(0.74)	0.034	(0.86)	0.029	(0.74)
Nonferrous sheet metal	0.036	(0.91)	0.045	(1.14)	0.036	(0.91)

^a A sheet-metal wall of thickness less than that specified is acceptable if it is not less than 0.026 inch (0.66 mm) and the area surrounding the knockout has a thickness not less than 0.053 inch (1.35 mm).

7.1.3 Among the factors to be considered when judging a nonmetallic enclosure, including one of polymeric material, or a magnesium enclosure are:

- a) Mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Combustibility;
- e) Resistance to arcing;
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use; and
- g) For a polymeric enclosure, thermal aging.

7.1.4 For a polymeric enclosure all of the factors in 7.1.3 are considered with respect to aging. See Nonmetallic enclosure parts, Section 7.2; and Polymeric and Other Nonmetallic Materials, Section 34.

7.1.5 An overall enclosure for electrical components of an appliance intended for outdoor exposure shall have provision for drainage. See 20.1.1.12.

7.1.6 An appliance shall have provision for condensate drainage that shall be located below the lowest electrical part when installed as intended. The smallest dimension of the hole shall be at least 1/2 inch (12.7 mm).

7.2 Nonmetallic enclosure parts

7.2.1 Polymeric material or other material having a flame-spread rating greater than zero in accordance with the Standard for Tests for Surface Burning Characteristics of Building Materials, UL 723, shall not be employed as an enclosure or a skirt or other part of a venturi system of an appliance that is intended to be:

- a) Permanently connected electrically and
- b) Installed within a building structure so that the portion of the appliance enclosed within the wall is not visible to the user.

7.2.2 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.2.3 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: This requirement is not applicable to exterior surfaces of polymeric enclosure materials or parts provided that the metallized coating or paint does not offer a continuous path for an internal flame to propagate externally.

7.2.4 A fan blade (air impeller) of polymeric material outside a motor shall not be located within 1 inch (25.4 mm) of an opening in the motor housing.

Exception: A fan blade may be within 1 inch of an opening in the motor housing if:

- a) The material is classed as V-2, V-1, V-0, or V in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, or*
- b) The material complies with the requirements for enclosure flammability using a 3/4-inch (19.1-mm) flame, in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, or*
- c) No motor opening within 1 inch of the blade has a dimension more than 17/64 inch (6.75 mm) or an area more than 0.055 square inch (35.5 mm²), and no more than six such openings are provided, or*
- d) In a skeleton or open frame type motor,*
 - 1) The fan blade is of material classed HB or less flammable in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94,*
 - 2) The coil is completely wrapped with insulation at least 1/32 inch (0.8 mm) thick, and*
 - 3) The space between the coil wrap and bobbin does not exceed 1/32 inch, or*
- e) The material has a hot wire ignition rating of at least 7 seconds as described in the Standard Test Method for Ignition of Materials by Hot Wire Sources, ASTM D3874, or*

f) The fan employs a thermally protected motor to drive the blade and complies with the test requirements in the Blade Ignition Test, Section 55.

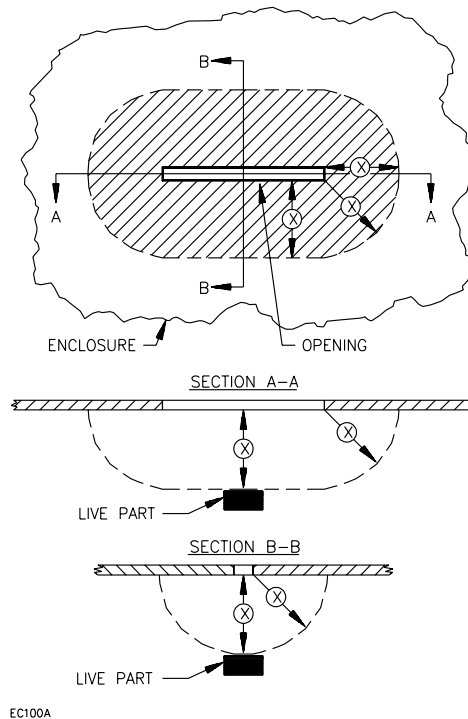
7.3 Accessibility of live parts

7.3.1 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from uninsulated live parts and film-coated wire, an opening in an enclosure of an appliance or in a motor shall be investigated as described in (a) or (b):

- a) For an opening that has a minor dimension (see 7.3.5) less than 1 inch (25.4 mm), such a part and film-coated wire shall not be contacted by the probe illustrated in Figure 7.1.
- b) For an opening that has a minor dimension of 1 inch or more, neither an uninsulated live part nor film-coated wire shall be within X inches of the perimeter of the opening or within the volume generated by projecting the perimeter X inches normal to its plane. X equals five times the minor dimension of the opening, but not less than 6-1/16 inches (154 mm). See Figure 7.2.

Exception: A motor need not comply with these requirements if it complies with the requirements in 7.3.2.

Figure 7.2
Opening in enclosure



7.3.2 With respect to a part or wire as mentioned in 7.3.1, in a motor as mentioned in the exception to 7.3.1:

a) An opening that has a minor dimension (see 7.3.5) less than 3/4 inch (19.1 mm) is acceptable if:

- 1) Film-coated wire cannot be contacted by the probe illustrated in Figure 7.4;
- 2) In a directly accessible motor (see 7.3.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 7.5; or
- 3) In an indirectly accessible motor (see 7.3.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 7.3.

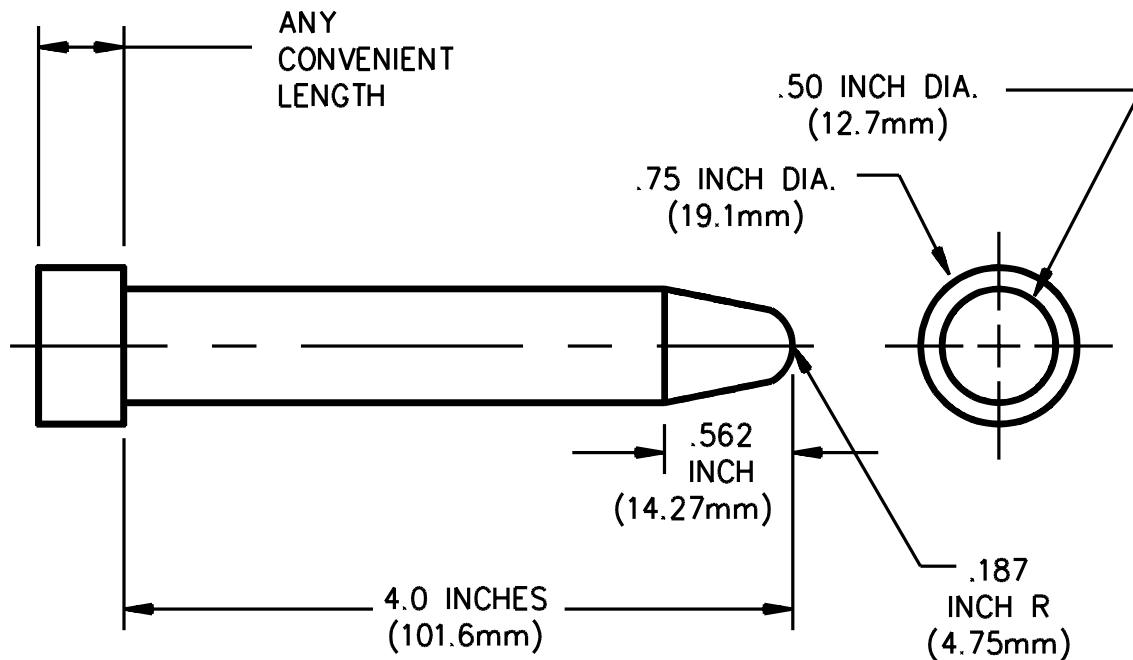
b) An opening that has a minor dimension of 3/4 inch or more is acceptable if an uninsulated live part or film-coated wire is not within X inches of the perimeter of the opening or within the volume generated by projecting the perimeter X inches normal to its plane. X equals five times the minor dimension of the opening, but not less than 3-5/32 inches (80 mm) for contact with an uninsulated live part through an opening in the enclosure of a directly accessible motor and 4 inches (102 mm) for all other openings. See Figure 7.2.

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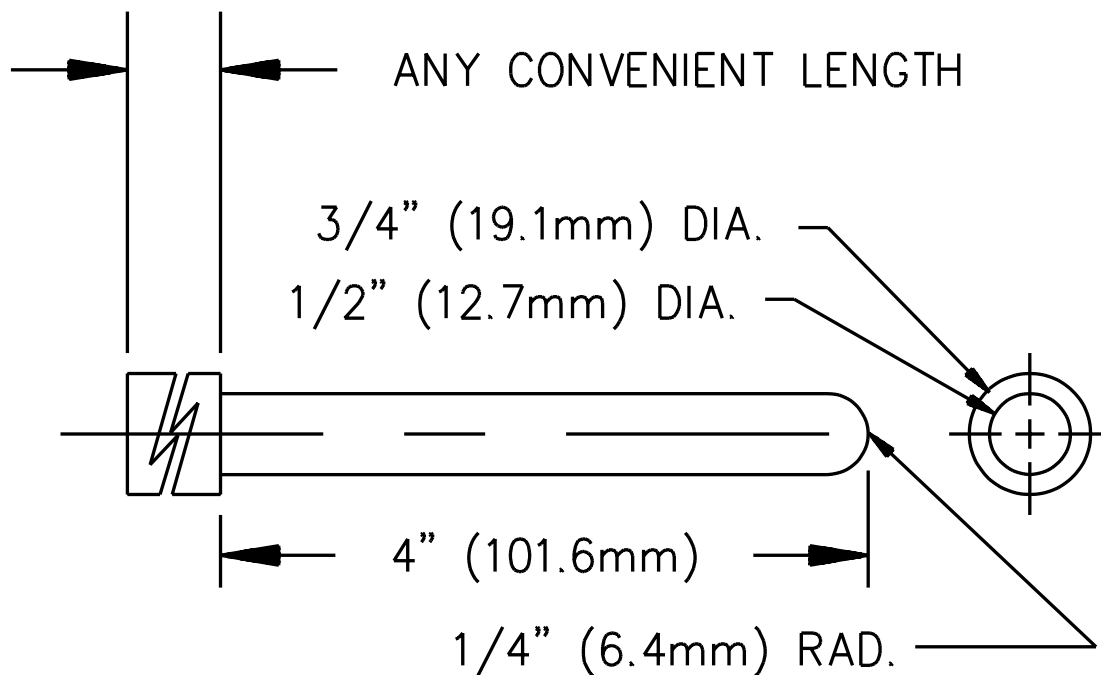
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Figure 7.3
Probe for uninsulated live parts



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Figure 7.4
Probe for film-coated wire



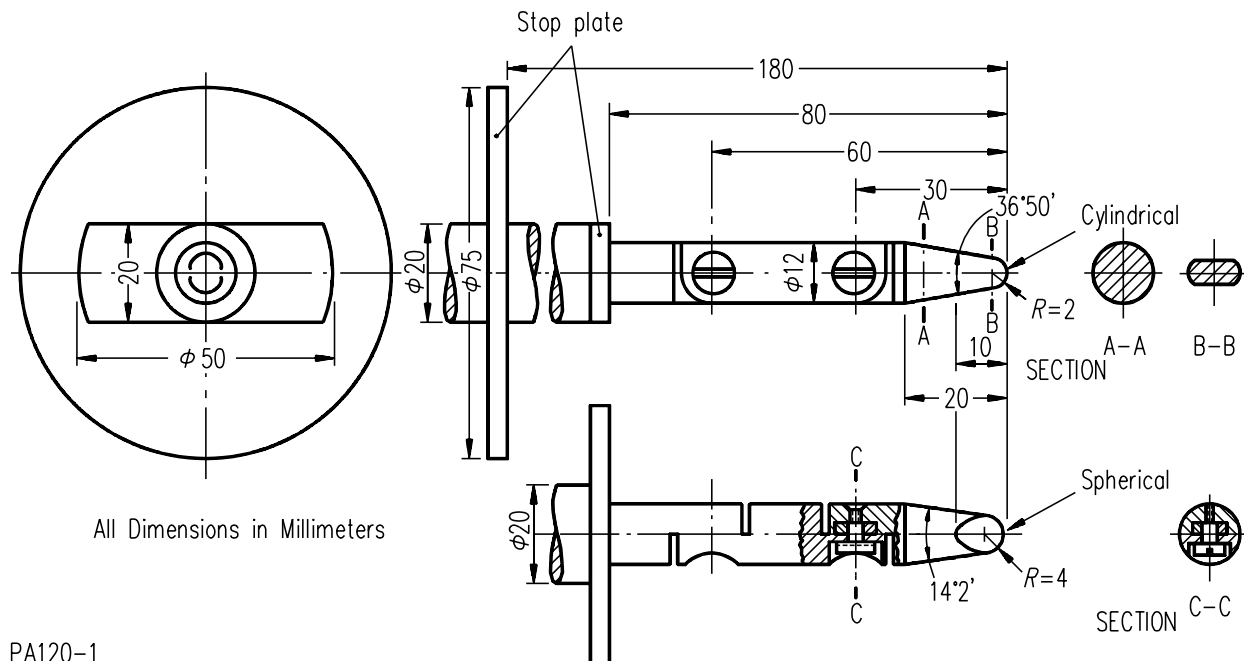
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Figure 7.5
IEC articulate probe



7.3.3 The probes mentioned in 7.3.1 and 7.3.2 and illustrated in Figures 7.1 and 7.3 – 7.5 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the appliance or motor. The probes illustrated in Figures 7.1 and 7.5 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

7.3.4 The probes mentioned in 7.3.1 and 7.3.2 and illustrated in Figures 7.1 and 7.3 – 7.5 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

7.3.5 With reference to the requirements specified in 7.3.1 and 7.3.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening perpendicular to the plane of the opening.

7.3.6 With reference to the requirements specified in 7.3.2, an indirectly accessible motor is a motor:

- a) That is accessible only by removing a part of the outer enclosure, such as a guard or panel, that can be removed without using a tool, or
- b) That is located at such a height above the floor or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is a motor that can be contacted without removing any part, or that is located so as to be accessible to contact.

7.3.7 During the examination of a product to determine whether it complies with the requirements in 7.3.1 and 7.3.2, a part of the enclosure that may be removed without using a tool (to attach an accessory, to make an operating adjustment or for other reasons) is to be removed.

7.3.8 With reference to 7.3.7, a filter(s) or exchange medium intended to be removed is to be removed – even if it is necessary to use tools to do so – when the appliance is being examined with reference to exposure of uninsulated live parts.

7.3.9 With reference to the requirements specified in 7.3.1 and 7.3.2, insulated brush caps are not required to be additionally enclosed.

7.3.10 If a motor employs leads that terminate in an attachment plug that is intended to be plugged into a receptacle provided as part of the appliance, uninsulated live parts and film-coated wire shall be located or protected, as judged in accordance with 7.3.1 – 7.3.4, to reduce the risk of unintentional contact by persons with, or damage to such parts during any cleaning operation.

7.3.11 With reference to 7.3.10, a layer of tape, at least 1/32 inch (0.8 mm) thick, on a coil is considered to provide the required protection.

8 Attachment Plugs, Receptacles, Connectors, and Terminals

8.1 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

Exception: Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of Standard for Cord Sets and Power-Supply Cords, UL 817 and need not comply with Standard for Attachment Plugs and Receptacles, UL 498.

8.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 0.110, 0.125, 0.187, 0.205, and 0.250 inch (2.8, 3.2, 4.8, 5.2, and 6.3 mm), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with Standard for Electrical Quick-Connect Terminals, UL 310.

8.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

8.4 Wire connectors shall comply with the Standard for Wiring Connectors, UL 486A-486B.

8.5 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

8.6 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

8.7 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if used for field wiring connection they shall be rated for field wiring.

8.8 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be rated for current interruption of the specific type of load, when evaluated with its mating plug or connector.

9 Controls

9.1 General

9.1.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product standard and the parameters in Controls – End Product Test Parameters, Section 37.

9.1.2 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in 9.2 – 9.4, and if applicable, the parameters in Controls – End Product Test Parameters, Section 37, unless otherwise specified in this end product standard.

9.1.3 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a risk of safety, such as a speed control unexpectedly changing its output, shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; and Standard for Software in Programmable Components, UL 1998; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.1.4 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in Sections 9.2 – 9.4, and if applicable, the parameters in Controls – End Product Test Parameters, Section 37, unless otherwise specified in this end product standard.

9.1.5 Solid-state protective controls that do not rely upon software as a protective component shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1, except Clause H.11.12 (Controls using software).

9.1.6 Protective controls that rely upon software as a protective component shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; and Standard for Software in Programmable Components, UL 1998; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.2 Electromechanical and electronic controls

9.2.1 A control, other than as specified in 9.3 – 9.4, shall comply with the:

- a) Standard for Temperature-Indicating and -Regulating Equipment, UL 873;
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; or
- c) Standard for Programmable Controllers – Part 2: Equipment Requirements and Tests, UL 61131-2.

9.3 Motor and speed control

9.3.1 A control used to start, stop, regulate or control the speed of a motor shall comply with the:

- a) Standard for Temperature-Indicating and –Regulating Equipment, UL 873;
- b) Standard for Industrial Control Equipment, UL 508;
- c) Standard for Power Conversion Equipment, UL 508C; or
- d) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

9.4 Temperature controls

9.4.1 A temperature control shall comply with the:

- a) Standard for Temperature-Indicating and -Regulating Equipment, UL 873;
- b) Standard for Industrial Control Equipment, UL 508; or
- c) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

9.4.2 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with the Standard for Thermistor-Type Devices, UL 1434.

9.4.3 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

10 Light sources and associated components

10.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with the Standard for Luminaires, UL 1598, are considered to fulfill this requirement.

10.2 Lighting ballasts shall comply with the:

- a) Standard for Fluorescent-Lamp Ballasts, UL 935; or
- b) Standard for High-Intensity Discharge Lamp Ballasts, UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with the Standard for Luminaires, UL 1598, are considered to fulfill this requirement.

10.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750.

11 Cords, Cables, and Internal Wiring

11.1 A cord set or power supply cord shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817.

11.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62.

11.3 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

Exception No. 1: Insulated conductors need not comply with the Standard for Appliance Wiring Material, UL 758, if they comply with the:

- a) Standard for Thermoset-Insulated Wires and Cables, UL 44;*
- b) Standard for Thermoplastic-Insulated Wires and Cables, UL 83; or*
- c) Standard for Fixture Wire, UL 66.*

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with the Standard for Appliance Wiring Material, UL 758.

12 Power Supplies

12.1 A Class 2 power supply shall comply with the:

- a) Standard for Class 2 Power Units, UL 1310;
- b) Standard for Information Technology Equipment Safety, Part 1: General Requirements, UL 60950-1, with an output marked "Class 2"; or
- c) Standard for Information Technology Equipment Safety, Part 1: General Requirements, UL 60950-1, with an output that complies with the limited power source (LPS) requirements and is marked "LPS".

12.2 A non-Class 2 power supply shall comply with the:

- a) Standard for Power Units Other Than Class 2, UL 1012; or
- b) Standard for Information Technology Equipment Safety, Part 1: General Requirements, UL 60950-1.

13 Printed Wiring Boards

13.1 Printed wiring boards, including the coatings, shall comply with the Standard for Printed-Wiring Boards, UL 796.

Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in the Standard for Printed-Wiring Boards, UL 796, if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.

14 Supplemental Insulation, Insulating Bushings, and Assembly Aids

14.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 22.14 or a performance requirement of this standard.

14.2 In accordance with 14.1, the supplemental insulation shall comply with the following:

- a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;
- b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441;
- c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224; and
- d) Electrical insulation systems shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

14.3 Insulating bushings that comply with Components, Section 6, of this end product standard, and the Standard for Insulating Bushings, UL 635, are considered to fulfill the construction requirements of this Standard. Tests specified in this Standard (e.g. Strain Relief Test) may still need to be performed to confirm the combination of the insulating bushing and the supporting parts comply with the performance requirements.

15 Valves (Electrically Operated) and Solenoids

15.1 Electrically operated valves shall comply with the:

- a) Standard for Electrically Operated Valves, UL 429; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8.

16 Transformers

16.1 General-purpose transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

Exception No. 1: A transformer that is completely enclosed within the end product enclosure, and that meets the applicable construction and performance requirements of this end product standard meets the intent of this requirement.

Exception No. 2: A transformer that complies with the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411, and that is used in a circuit involving an audio or video component, meets the intent of this requirement.

16.2 Class 2 and Class 3 transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception: Transformers located in a low voltage circuit, and that do not involve a risk of fire or personal injury, need not comply with this requirement.

17 Protection Against Corrosion

17.1 Metal shall be used in combinations that are galvanically compatible.

17.2 An iron or steel part shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

Exception: The following parts need not be protected against corrosion:

- a) A shaft, bearing, lamination, or minor part, such as a washer, screw, and the like.*
- b) A cast-metal part that derives inherent protection by virtue of its thickness.*
- c) A part, such as a decorative grille, that is not required to form a part of an enclosure.*
- d) A part whose corrosion is not likely to result in a risk of fire, electric shock, or injury to persons.*

17.3 Hinges and other attachments shall be resistant to corrosion.

17.4 A sheet steel enclosure shall be protected against corrosion as specified in Table 17.1.

Exception: An enclosure of a product not intended for outdoor exposure shall comply with the requirement in 17.2.

Table 17.1
Protection against corrosion

Enclosure use	Thickness of sheet steel and reference in standard for type of protection required	
	0.053 inch (1.35 mm) or more	Less than 0.053 inch
Outer enclosure protecting motors, wiring, or enclosed live parts	6.8 or 6.9	6.8
Outer enclosure that is the sole enclosure of live parts	6.8	
Outer enclosure that does not enclose electrical parts	6.8 or 6.9	6.8 or 6.9
Interior enclosure protecting live parts other than motors	6.8 or 6.9	6.8

17.5 Aluminum, brass, copper, or stainless steel may be used without additional protection against corrosion.

17.6 A nonmetallic enclosure intended to be used outdoors shall be judged on the basis of the effect of exposure to ultraviolet light and water.

17.7 An enclosure of cast iron at least 1/8 inch (3.2 mm) thick is considered to be protected by one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

17.8 To comply with Table 17.1, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G90 in Table I of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M.
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be established by the metallic coating thickness test described in Section 51. An annealed coating shall also comply with 17.12.
- c) A zinc coating conforming with 17.9 (a) or (b) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface applied after forming. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.
- d) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established in accordance with the metallic-coating-thickness test as described in Section 51.
- e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the metallic-coating-thickness test described in Section 51 and the paint shall be as specified in (c).

17.9 To comply with Table 17.1, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G60 or A60 in Table I of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M.
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness at least 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the metallic-coating-thickness test described in Section 51.
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint is to be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

17.10 With reference to 17.8 and 17.9, other finishes, including paints, metallic finishes, and combinations of the two may be accepted if comparative tests with galvanized sheet steel – without annealing, wiping or other surface treatment – conforming with 17.8(a) or 17.9(a), as applicable, indicate they provide equivalent protection. Among the factors that are to be taken into consideration when judging the suitability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

17.11 If tests are required, test specimens of a finish as described in 17.7 or 17.10 or 17.8(c) or 17.9(c), are to be consistent with the finish that is to be used in production with respect to the base metal, cleaning or pretreatment method, application method, number of coats, curing method, thickness, and the like.

17.12 A hot-dipped mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing and that is not otherwise required to be painted shall be painted in the bent or formed area if the bending or forming process damages the zinc coating, except that such areas on the inside surface of an enclosure that is not exposed to water during the water spray test need not be painted. The zinc coating is considered to be damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification. Simple sheared or cut edges and punched holes are not considered to be formed.

18 Protection Against Risk of Fire

18.1 The enclosure of an appliance shall prevent molten metal, burning insulation, flaming particles, and the like from falling onto flammable materials, including the surface upon which the appliance is supported if the appliance is:

- a) Installed in a remote location;
- b) Thermostatically or automatically controlled; or
- c) Intended to be operated unattended.

18.2 The requirements in 18.1 will necessitate the use of a barrier or material having a zero flame spread rating when tested in accordance with the Standard for Tests for Surface Burning Characteristics of Building Materials, UL 723:

- a) Under a motor unless:
 - 1) The structural parts of the motor or of the appliance provide the equivalent of such a barrier, or
 - 2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance or into the wiring compartment when the motor is energized under each of the following fault conditions:
 - i) Open main winding,
 - ii) Open auxiliary winding,
 - iii) Starting switch short-circuited, and
 - iv) Capacitor of a permanent-split, capacitor motor short-circuited and the rotor locked – the short-circuit is to be applied before the motor is energized, or

3) The motor is provided with a thermal motor protector that will prevent the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked, or

Exception: Direct drive fan motors need only be subjected to the locked rotor test.

4) The motor complies with the requirements for impedance-protected motors in the Standard for Overheating Protection for Motors, UL 2111, or the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and the Standard for Thermally Protected Motors, UL 1004-3, and the temperature of the motor winding does not exceed 150°C during the first 72 hours of operation with the rotor of the motor locked.

b) Under wire, unless the wire

1) Is neoprene or thermoplastic insulated, such as wire marked VW-1, or

2) Has at least equivalent characteristics as determined in the flame tests specified in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

c) Under a switch, relay, solenoid, or the like unless:

1) A short circuit or overload in the component would not result in a risk of fire, or

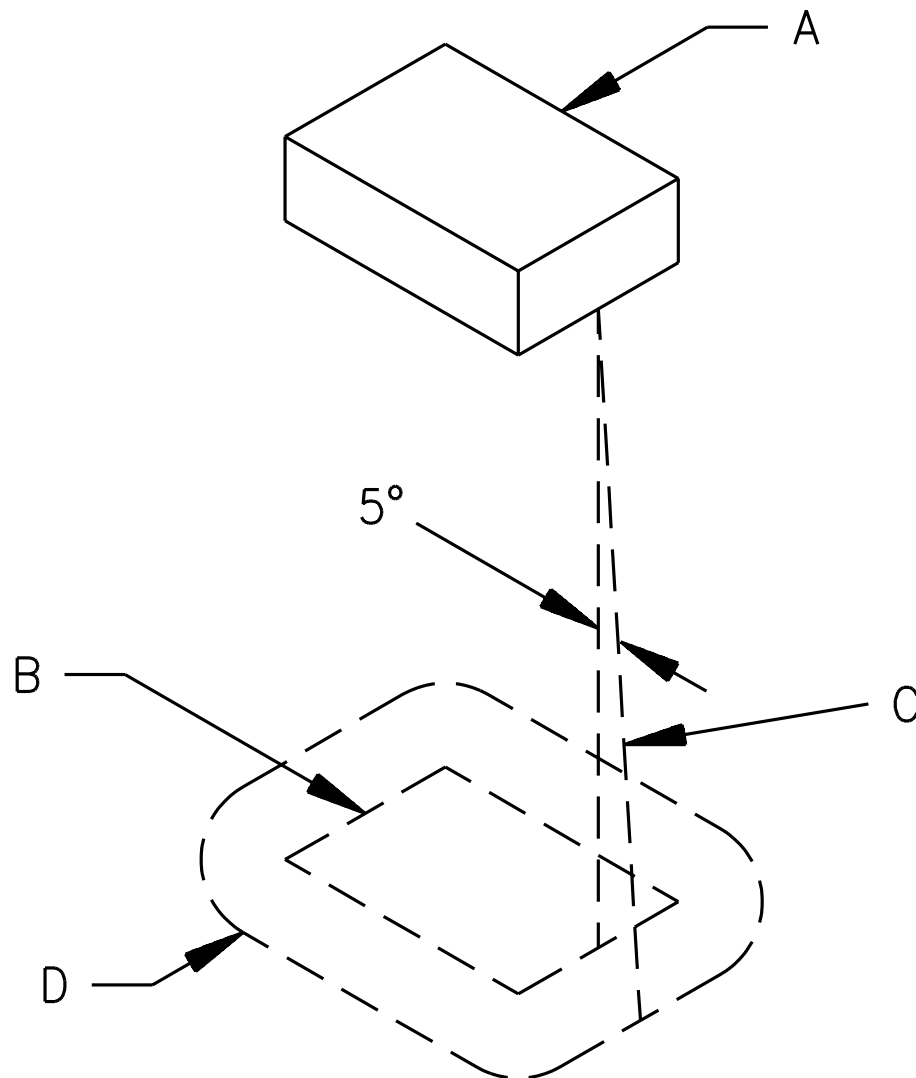
2) There are no openings in the enclosure through which molten metal, burning insulation, flaming particles, or the like can fall.

Exception: A terminal need not have a barrier.

UL 1004-3 will replace Part III of UL 2111 effective September 15, 2014

18.3 The barrier specified in 18.2 shall be horizontal, shall be located as illustrated in Figure 18.1, and shall have an area in accordance with the illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier provided such openings would not permit molten metal, burning insulation, or the like, to fall onto flammable material.

Figure 18.1
Barrier



EB120A

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded and will consist of the unshielded portions of a component that is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always (1) tangent to the component, (2) 5 degrees from the vertical, and (3) so oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

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18.4 A ventilating opening provided in:

- a) The enclosure of an appliance or
- b) An externally mounted component of an appliance,

and that is intended to be recessed into a wall or false ceiling shall not vent into a concealed space where the spread of a fire might occur undetected.

19 Mechanical Assembly

19.1 An appliance shall be assembled so that its intended performance will not be impaired by the vibration of normal operation. Brush caps shall be tightly threaded or otherwise designed to prevent loosening.

19.2 A switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely, and shall be prevented from turning or shifting. See 19.3.

Exception No. 1: A switch need not be prevented from turning if the following conditions are met:

- a) The switch is a plunger or other type that does not tend to rotate when operated – a toggle switch is considered to be subject to such forces;*
- b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it;*
- c) Spacings are not reduced below the minimum acceptable values if the switch is rotated; and*
- d) Normal operation of the switch is by mechanical means rather than by direct contact by persons.*

Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator lamp in which the lamp is sealed in by a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

19.3 The means for preventing turning, as required by 19.2, shall consist of more than friction between surfaces – for example, a toothed lock washer that provides spring take-up, applied as intended, is an acceptable means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

19.4 A household appliance shall be completely assembled when it is shipped from the factory, except that shipment partially disassembled to facilitate packaging or installation is acceptable if intended assembly can be readily accomplished without resulting in a risk of fire, electric shock, or injury to persons. If mismatching of components of an appliance shipped disassembled could result in a risk of fire, electric shock, or injury to persons, the parts shall be marked as specified in 72.1.5.

19.5 A commercial or industrial appliance shall be completely assembled when shipped from the factory.

Exception: A commercial or industrial appliance marked in accordance with 72.2.5 need not be completely assembled when shipped from the factory.

19.6 If a part is shipped disassembled from an appliance and if it is necessary to make field connections to that part:

- a) The appliance shall be constructed so that it can be permanently connected to one of the wiring systems that would be acceptable for the appliance;
- b) Wiring terminals or leads to which the field connections are to be made shall comply with the requirements for field-wiring terminals, including those for spacings;
- c) The marking information required by 73.7 shall be provided; and
- d) Means for mounting a disconnect switch assembly that is part of the appliance shall be provided.

19.7 A disconnect switch assembly that is shipped mounted on the appliance:

- a) Shall be factory-wired to the remainder of the appliance; or
- b) Shall comply with the requirements in 19.6 (a), (b), and (c) and those in 72.2.5.

19.8 Internal connections that must be made in the field in a cord-connected appliance that is shipped partially disassembled shall be made by plug and receptacle connections. Internal connections that must be made in the field in an appliance intended for permanent connection to the power supply and shipped partially disassembled shall be made in accordance with 20.1.1.1 and 20.1.1.6 or by plug and receptacle connection.

19.9 Unless the intended method of assembly is obvious, an appliance that is shipped from the factory partially disassembled shall be provided with clear and detailed assembly instructions.

19.10 An appliance that is shipped from the factory partially disassembled and is not marked in accordance with 72.1.5 shall be shipped in a single shipping container.

19.11 Uninsulated live parts of a thermostat provided with a welded stop shall not contact dead metal parts or parts of opposite polarity if breakage of the welded stop would permit the thermostat to rotate.

19.12 A mounting bracket necessary for installation shall be furnished. See 72.2.7.

Exception: For an appliance that is acceptable for use with any of a number of mounting brackets or assemblies provided separately, a bracket or assembly need not be provided if appropriate reference to such devices are included in the installation instructions.