

UL 1815

ISBN 1-55989-837-2

Nonducted Heat Recovery Ventilators



Northbrook, Illinois • (708) 272-8800

Melville, New York • (516) 271-6200

Santa Clara, California • (408) 985-2400

Research Triangle Park,

North Carolina • (919) 549-1400

**Underwriters Laboratories Inc.®**

Underwriters Laboratories Inc., founded in 1894, is chartered as a not-for-profit organization without capital stock, under the laws of the State of Delaware, to establish, maintain, and operate laboratories for the examination and testing of devices, systems and materials to determine their relation to hazards to life and property, and to ascertain, define and publish standards, classifications and specifications for materials, devices, products, equipment, constructions, methods, and systems affecting such hazards.

UL Standards for Safety are developed under a procedure which provides for participation and comment from the affected public as well as industry. The procedure takes into consideration a survey of known existing standards and the needs and opinions of a wide variety of interests concerned with the subject matter of the standard. Thus manufacturers, consumers, individuals associated with consumer-oriented organizations, academicians, government officials, industrial and commercial users, inspection authorities, insurance interests and others provide input to UL in the formulating of UL Standards for Safety, to keep them consonant with social and technological advances.

A not-for-profit organization
dedicated to public safety and
committed to quality service



Underwriters Laboratories Inc.®

A not-for-profit organization dedicated to public safety
and committed to quality service

April 11, 1995

Standard for

Nonducted Heat Recovery Ventilators

UL 1815, Second Edition

Accompanying this transmittal notice is a copy of the Second edition of UL 1815.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

Revised and/or additional pages may be issued from time to time.



Documents

Document Sharing Hub

APRIL 11, 1995

1

UL 1815

Standard for

Nonducted Heat Recovery Ventilators

First Edition – April 10, 1990

Second Edition

April 11, 1995

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

ISBN 1-55989-837-2

COPYRIGHT © 1990, 1995 UNDERWRITERS LABORATORIES INC.

CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	6

CONSTRUCTION

4 General	7
5 Frame and Enclosure	7
6 Protection Against Corrosion	14
7 Protection Against Risk of Fire	17
8 Mechanical Assembly	19
9 Power Supply Connections	21
10 Live Parts	27
11 Internal Wiring	27
12 Heating Elements	29
13 Insulating Material	30
14 Lampholders	30
15 Receptacles	30
16 Motors	30
17 Thermostats	32
18 Limiting Controls	33
19 Grounding	33
20 Capacitors	34
21 Spacings	34
22 Filters	38
23 Overload-Protective Devices	38
24 Switches, Including Motor Controllers	39

PROTECTION AGAINST INJURY TO PERSONS

25 General	40
26 Accessories	40
27 Switches and Controls	40
28 Enclosures and Guards	40
29 Temperature	43

PERFORMANCE

30 General	43
31 Starting Current Test	43
32 Leakage Current Test	44
33 Input Test	47
34 Temperature Test	47
35 Undervoltage Test	54
36 Dielectric Voltage-Withstand Test	55
37 Water Spray Test	55

38	Metallic Coating Thickness Test	60
39	Continuity of Grounding Circuit Test	61
40	Capacitor Tests	61
41	Humidity Conditioning Test	62
42	Blade Ignition Test	62
43	Strain Relief Test	63
44	Abnormal Operation Tests	64
45	Abnormal Heating	64
46	Endurance	65
47	Thermal Cutoffs	65
48	Tests of Switches and Controls	65
49	Bonding Connection Test	66
50	Conformal Coatings Tests	66
51	Permanence of Marking Tests	66
52	Condensation Test	66

MANUFACTURING AND PRODUCTION TESTS

53	Dielectric Voltage-Withstand Test	68
54	Grounding Continuity Test	69

INSTALLATION INSTRUCTIONS

55	Details	70
----	---------------	----

RATING

56	Details	70
----	---------------	----

MARKING

57	Details	70
58	Important Safety Instructions	74

APPENDIX A

Standards for Components	A1
--------------------------------	----

FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

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, 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.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involve a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being 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 for which they have been recognized.

2.2 Undated references

2.2.1 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.

2.3 Units of measurement

2.3.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

3 Glossary

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

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

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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

4 General

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

5 Frame and Enclosure

5.1 General

5.1.1 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.

5.1.2 A cast- or sheet-metal section of the enclosure shall not be thinner than the applicable value specified in Table 5.1.

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 5.1.

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 5.1 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*
- d) *Location on the appliance.*

Table 5.1
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).

5.1.3 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.

5.1.4 An overall enclosure for electrical components of an appliance intended for outdoor exposure shall have provision for drainage. See 9.1.1.12.

5.1.5 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).

5.2 Nonmetallic enclosure parts

5.2.1 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.

5.2.2 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 94V-2, 94V-1, 94V-0, or 94-5V 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 94-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 D3874-1988, 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 42.*

5.3 Accessibility of live parts

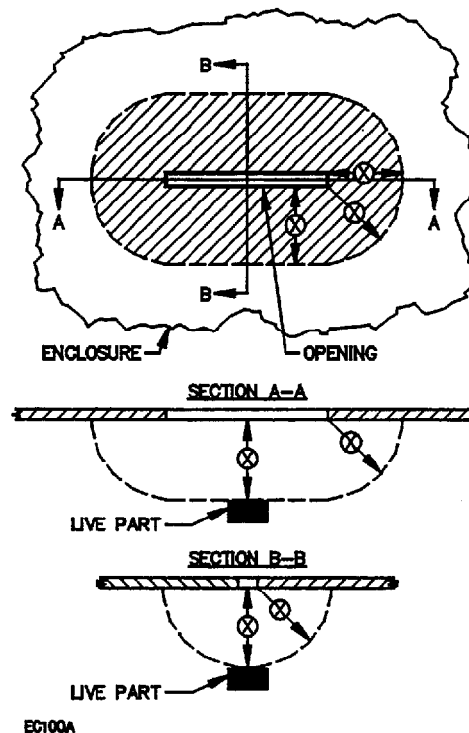
5.3.1 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from uninsulated live parts and film-coated wire, an opening in an enclosure of an appliance or in a motor shall be investigated as described in (a) or (b):

- a) For an opening that has a minor dimension (see 5.3.5) less than 1 inch (25.4 mm), such a part and film-coated wire shall not be contacted by the probe illustrated in Figure 5.1.
- 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 5.2.

Exception: A motor need not comply with these requirements if it complies with the requirements in 5.3.2.

[illegible]

Figure 5.2
Opening in enclosure



5.3.2 With respect to a part or wire as mentioned in 5.3.1, in a motor as mentioned in the exception to 5.3.1:

- a) An opening that has a minor dimension (see 5.3.5) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) Film-coated wire cannot be contacted by the probe illustrated in Figure 5.4;
 - 2) In a directly accessible motor (see 5.3.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 5.5; or
 - 3) In an indirectly accessible motor (see 5.3.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 5.3.
- 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 5.2.

Figure 5.3
Probe for uninsulated live parts

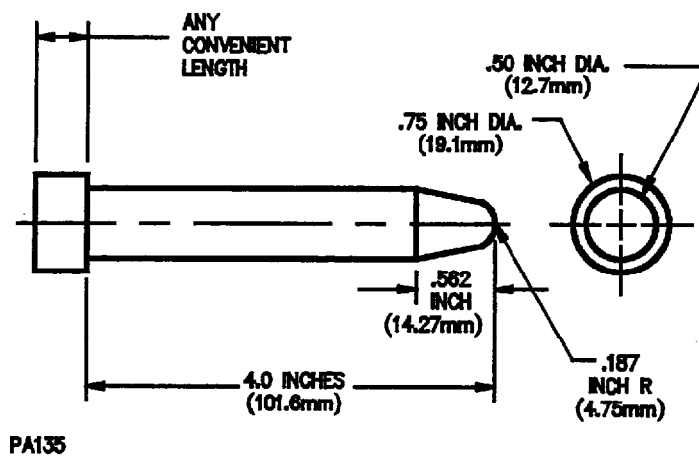


Figure 5.4
Probe for film-coated wire

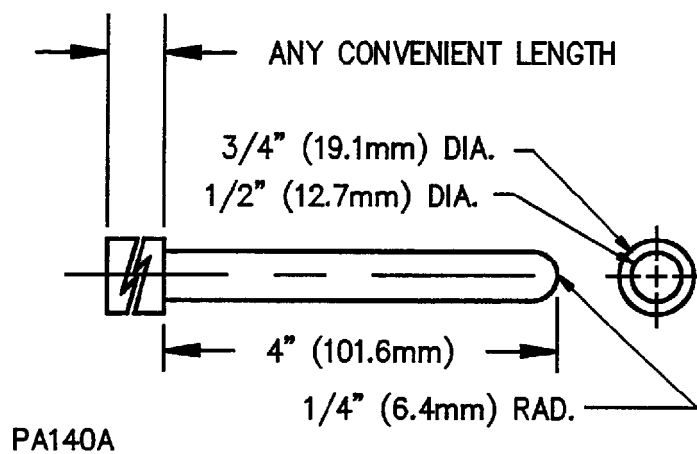
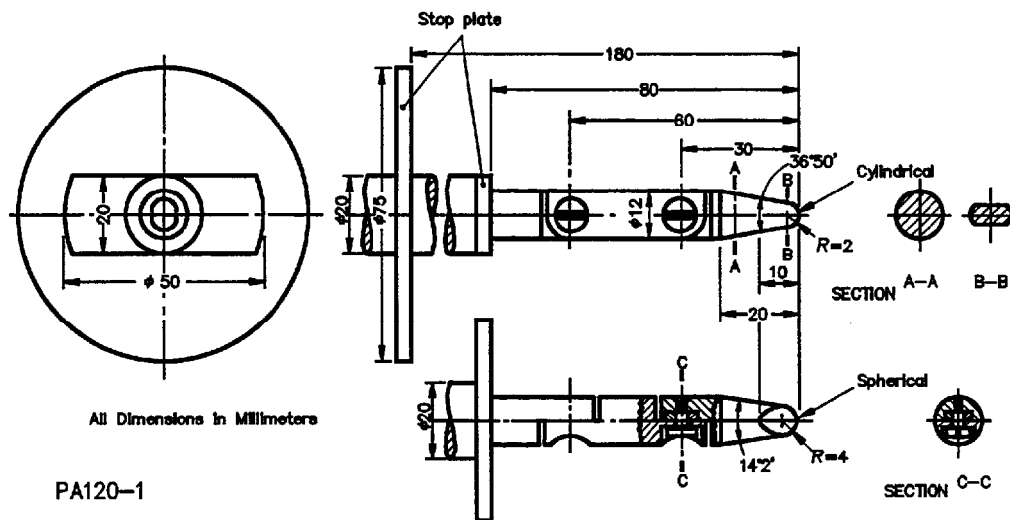


Figure 5.5
IEC articulate probe



5.3.3 The probes mentioned in 5.3.1 and 5.3.2 and illustrated in Figures 5.1 and 5.3 – 5.5 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 5.1 and 5.5 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

5.3.4 The probes mentioned in 5.3.1 and 5.3.2 and illustrated in Figures 5.1 and 5.3 – 5.5 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.

5.3.5 With reference to the requirements specified in 5.3.1 and 5.3.2, 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.

5.3.6 With reference to the requirements specified in 5.3.2, an indirectly accessible motor is a motor:

- 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
- 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.

5.3.7 During the examination of a product to determine whether it complies with the requirements in 5.3.1 and 5.3.2, 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.

5.3.8 With reference to 5.3.7, 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.

5.3.9 With reference to the requirements specified in 5.3.1 and 5.3.2, insulated brush caps are not required to be additionally enclosed.

5.3.10 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 5.3.1 — 5.3.4, to reduce the risk of unintentional contact by persons with, or damage to such parts during any cleaning operation.

5.3.11 With reference to 5.3.10, a layer of tape, at least 1/32 inch (0.8 mm) thick, on a coil is considered to provide the required protection.

6 Protection Against Corrosion

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

6.2 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.*

6.3 Hinges and other attachments shall be resistant to corrosion.

6.4 A sheet steel enclosure shall be protected against corrosion as specified in Table 6.1.

Exception: An enclosure of a product not intended for outdoor exposure shall comply with the requirement in 6.2.

Table 6.1
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

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

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

6.7 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.

6.8 To comply with Table 6.1, 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 for Sheet Steel, Zinc-Coated by the Hot-Dip Process, ASTM A525-86, 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 of the Standard for the Weight of Coating on Zinc-Coated Iron or Steel Articles, ASTM A90-81.

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 39. An annealed coating shall also comply with 6.12.

c) A zinc coating conforming with 6.9 (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 38.

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 38 and the paint shall be as specified in (c).

6.9 To comply with Table 6.1, 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 for Sheet Steel, Zinc-Coated by the Hot-Dip Process, ASTM A525-86, 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 of the Standard for the Weight of Coating on Zinc-Coated Iron or Steel Articles, ASTM A90-81.

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 38.

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.

6.10 With reference to 6.8 and 6.9, 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 6.8(a) or 6.9(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.

6.11 If tests are required, test specimens of a finish as described in 6.7 or 6.10 or 6.8(c) or 6.9(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.

6.12 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.

7 Protection Against Risk of Fire

7.1 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.

7.2 The requirements in 7.1 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:
 - a) Open main winding,
 - b) Open auxiliary winding,
 - c) Starting switch short-circuited, and
 - d) 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 Impedance-Protected Motors, UL 519, 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.

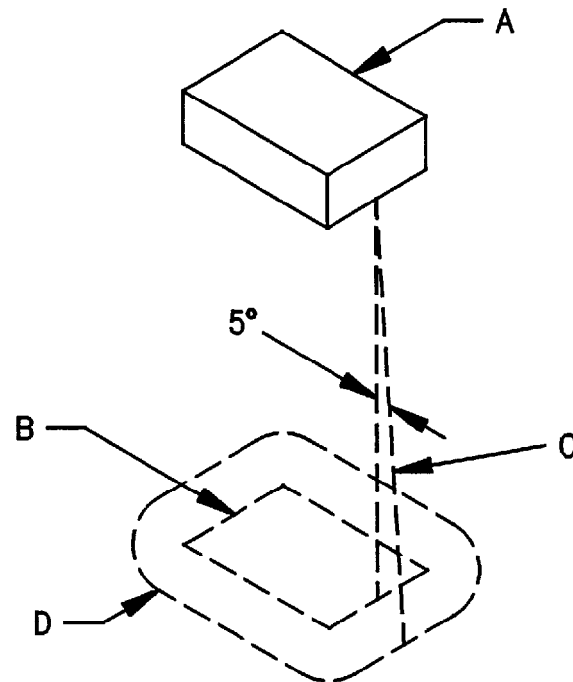
7.3 The barrier specified in 7.2 shall be horizontal, shall be located as illustrated in Figure 7.1, and shall have an area in accordance with the illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier provided such openings would not permit molten metal, burning insulation, or the like, to fall onto flammable material.

7.4 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.

Figure 7.1
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.

8 Mechanical Assembly

8.1 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.

8.2 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 8.3.

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.

8.3 The means for preventing turning, as required by 8.2, 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.

8.4 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 57.1.5.

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

Exception: A commercial or industrial appliance marked in accordance with 57.2.5 need not be completely assembled when shipped from the factory.

8.6 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 57.2.7 shall be provided; and
- d) Means for mounting a disconnect switch assembly that is part of the appliance shall be provided.

8.7 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 8.6(a), (b), and (c) and those in 57.2.7.

8.8 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 9.1.1.1 and 9.1.1.6 or by plug and receptacle connection.

8.9 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.

8.10 An appliance that is shipped from the factory partially disassembled and is not marked in accordance with 57.1.5 shall be shipped in a single shipping container.

8.11 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.

8.12 A mounting bracket necessary for installation shall be furnished. See 57.1.5.

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.

9 Power Supply Connections

9.1 Permanently connected appliances

9.1.1 General

9.1.1.1 An appliance intended for permanent connection to the power supply shall be constructed so that it may be permanently connected electrically to one of the wiring systems that would be acceptable for the appliance in accordance with the National Electrical Code, ANSI/NFPA 70-1990.

9.1.1.2 A knockout in a sheet-metal enclosure provided for connection of the appliance to a wiring system installed in accordance with the National Electrical Code, ANSI/NFPA 70-1990, shall be securely attached and removable without deformation that would impair the intended performance of the enclosure.

9.1.1.3 A flat surface shall surround a knockout and shall be of sufficient area to permit the attachment of a length of standard rigid metallic conduit of a size corresponding to the size of the knockout. The flat area shall have a minimum diameter in accordance with Table 9.1.

9.1.1.4 The diameter of a knockout shall accommodate conduit of the trade size for which the knockout is intended as specified in Table 9.1.

9.1.1.5 With reference to the requirement specified in 9.1.1.1, an appliance intended for permanent attachment to a building structure or a duct-connected appliance shall be provided with means for permanent electrical connection to the power supply.

Exception: An appliance need not be provided with a means for permanent electrical connection if it is provided with a power-supply cord that:

- a) Is at least 18 inches (0.5 m) and not more than 10 feet (3 m) long,
- b) Has three conductors, one being an equipment-grounding conductor,
- c) Is Type S, SJ, SJO, SJT, SO, SP-3, SPT-3, or ST,
- d) Is permanently attached to the appliance, and
- e) Complies with the requirements in 9.2.1.2 and 9.2.2.1 – 9.2.2.5.

9.1.1.6 A field-wiring compartment in which power-supply connections are to be made shall be located so that the connections may be readily inspected after the appliance is installed as intended.

Table 9.1
Dimensions associated with openings for conduit

Trade size of conduit, inches	Unthreaded openings		Threaded openings	
	Nominal knockout diameter, inches (mm)	Minimum diameter of flat surface at knockout, inches (mm)	Throat diameter, inches (mm)	
			Minimum	Maximum
1/2	7/8 (22.2)	1.152 (29.26)	0.591 (15.01)	0.622 (15.80)
3/4	1-3/32 (27.8)	1.450 (36.83)	0.783 (19.89)	0.824 (20.93)
1	1-23/64 (34.5)	1.804 (45.82)	0.997 (25.32)	1.049 (26.64)
1-1/4	1-23/32 (43.7)	2.309 (58.65)	1.311 (33.3)	1.380 (35.05)

9.1.1.7 Accessibility of field installed wiring and inspection of splices is to be judged by:

- a) a trial installation following any instructions provided by the manufacturer or
- b) using any wiring system permitted by the National Electrical Code, ANSI/NFPA 70-1987, if no instructions are provided.

9.1.1.8 The minimum usable volume of an outlet box or terminal compartment in which field-installed wiring connections to the power supply are to be made shall be as specified in Table 9.2.

Exception: A motor containing an integral wiring compartment that complies with the Standard for Electric Motors, UL 1004 need not comply with this requirement.