

UL 705

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Underwriters Laboratories Inc.®

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

March 7, 1996

Revision pages for

Standard for

Power Ventilators

UL 705, Fifth Edition

Attached to this transmittal notice is a revision of the Fifth edition of UL 705.

A CHANGE ON A PAGE DATED MARCH 7, 1996 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

The new and revised requirements are substantially in accordance with UL's bulletin on this subject dated November 2, 1995. The bulletin is now obsolete and may be discarded.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 705-1994.

Attention is directed to the note on the title page of this standard identifying that the Department of Defense has adopted the text of UL 705.

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

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	June 1, 1994 (Reprinted: March 7, 1996)
2	—
3	March 7, 1996
4	June 1, 1994
5, 6, 6A, 7 – 11	March 7, 1996
12, 12A	June 2, 1994
13 – 15	June 1, 1994

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March 7, 1996 – UL 705

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UL 705

Standard for

Power Ventilators

First Edition – December, 1966

Second Edition – July, 1972

Third Edition – November, 1977

Fourth Edition – December, 1984

The First through Third editions were titled Power Roof Ventilators.

Fifth Edition

June 1, 1994

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated June 1, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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

Approved as ANSI C33.89-1972, July 11, 1972

Approved as ANSI/UL 705-1977, May 11, 1977

Approved as ANSI/UL 705-1984, August 7, 1984

Approved as ANSI/UL 705-1994, February 14, 1994

The Department of Defense (DoD) has adopted UL 705 on February 5, 1993. The publication of revised pages or a new edition of this standard will not invalidate the DoD adoption.

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.

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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 power ventilators of the roof- and wall-mounted types and duct fans of the straight-through type intended for commercial or industrial use and for connection to permanently installed wiring systems in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover the following:

- a) Ventilating equipment such as attic, hood, or canopy fans or blowers;
- b) Air-moving equipment with integral air-tempering means;
- c) Ventilators rated more than 600 volts;
- d) Ventilators employing universal motors rated more than 250 volts;
- e) Air heaters equipped with fans;
- f) Draft fans for furnaces;
- g) Heating-ventilating units;
- h) Blowers employed as components in equipment such as furnaces, mechanical-refrigeration equipment, or air conditioners;
- i) Fusible links and the like that may be provided to disconnect a fan or close shutters in the event of fire;
- j) Ventilators specifically intended for use in exhausting any of the following: gases other than air, atmospheres causing corrosion to the ventilator, air with water spray, or flammable vapors; or
- k) Ventilators for the removal or conveyance of dust, stock, or refuse.

1.2 revised March 7, 1996

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves 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 acceptable the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific 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.

1.3 revised June 2, 1994

2 General

2.1 Glossary

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

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

2.1.3 **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 or provided as part of the ventilator.

2.1.4 **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.

2.1.5 **POWER VENTILATOR** — An air-moving appliance consisting 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.

2.1.6 **VENTILATOR** — A power ventilator or a duct fan.

2.2 Components

2.2.1 Except as indicated in 2.2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2.2 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.

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

2.2.4 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.

2.3 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.

2.4 Undated references

2.4.1 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.

2.4.1 added June 2, 1994

CONSTRUCTION

3 Frame and Enclosure

3.1 A ventilator 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 increasing the risk of fire, electric shock, or injury to persons due to a total or partial collapse with a resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

3.2 Among the factors taken into consideration when the acceptability of an enclosure is being judged are its:

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

3.3 A cast- or sheet-metal section of an enclosure shall have a thickness not less than that specified in Table 3.1.

Table 3.1
Minimum acceptable thickness of enclosure metal

Metal	Minimum thickness, Inch (mm)		
	At small, flat, unreinforced surfaces and at surface of a shape or size to ensure adequate mechanical strength	At surfaces to which a wiring system is to be connected in the field	At relatively large unreinforced flat surfaces
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 ^a (0.81)	0.026 (0.66)
Galvanized sheet steel	0.029 (0.74)	0.034 ^a (0.86)	0.029 (0.74)
Nonferrous sheet metal	0.036 (0.91)	0.045 (1.14)	0.036 (0.91)

^aA sheet-steel wall of thickness less than that specified is acceptable if the area surrounding the knockout has a thickness not less than 0.053 inch (1.35 mm).

3.4 Among the factors that shall be taken into consideration when judging the acceptability of magnesium and nonmetallic parts used for the enclosure of live parts are resistance to:

- Mechanical damage,
- Impact,
- Moisture absorption,
- Combustion,
- Effects of arcing,
- Distortion at temperatures to which the material may be subjected under conditions of normal or abnormal use, and
- Deterioration due to exposure to rain, sunlight, or the atmosphere.

For a nonmetallic enclosure, all these factors are considered with respect to thermal aging.

3.5 Electrical parts of a ventilator shall be located or enclosed so that protection against unintentional contact with uninsulated live parts will be provided.

3.6 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, or injury to persons from a moving part, the enclosure shall comply with the following:

- a) A probe as illustrated in Figure 3.2 shall not touch film-coated wire when inserted through an opening; and
- b) A probe as illustrated in Figure 3.4 cannot be made to touch any uninsulated live part when inserted through an opening;
- c) A probe as illustrated in Figure 3.5 shall not contact a moving part when inserted through an opening.

3.6 revised March 7, 1996

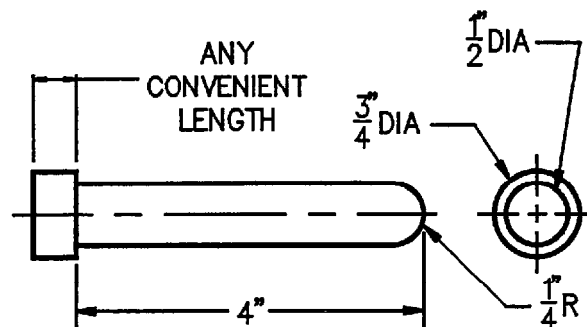
3.6.1 With reference to 3.6(b), the probe is to be applied in any possible configuration; and, if necessary, the configuration may be changed after insertion through the opening.

3.6.1 added March 7, 1996

Figure 3.1
Probe for uninsulated live parts

Figure 3.1 deleted March 7, 1996

Figure 3.2
Probe for film-coated wire



SB0612

Figure 3.3
Openings in enclosure

Figure 3.3 deleted March 7, 1996

Figure 3.4
Probe
(Other than moving parts)

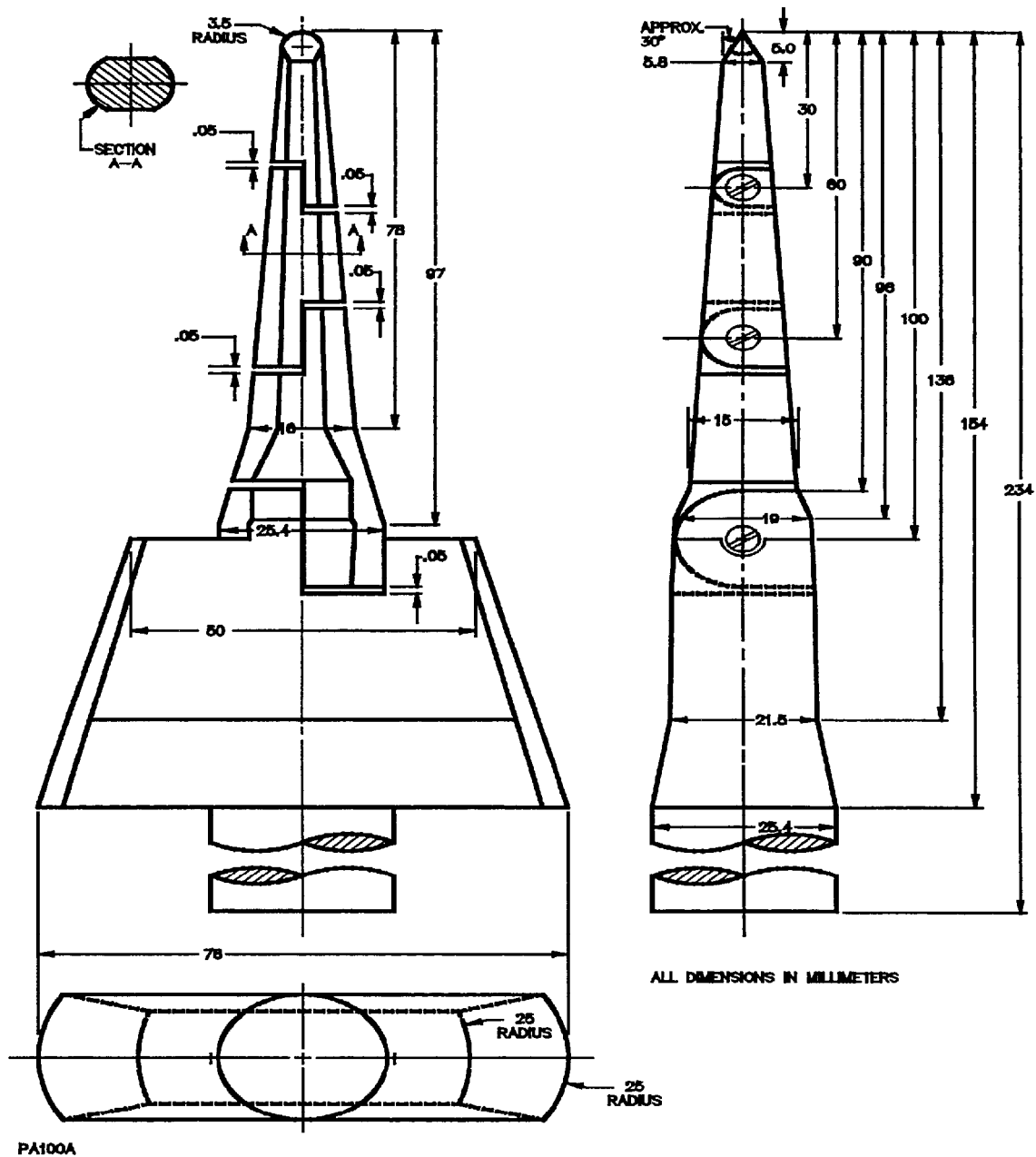
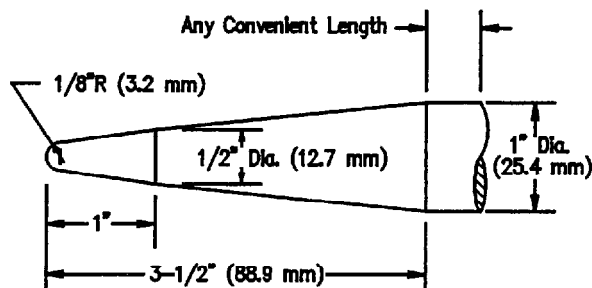


Figure 3.4 added March 7, 1996

Figure 3.5
Probe
(Moving parts)



PA 160

Figure 3.5 added March 7, 1996

3.7 Uninsulated live parts shall be located, guarded, or enclosed so as to reduce the likelihood of unintentional contact that may involve a risk of electric shock to persons performing operations such as oiling motors, replacing filters, or adjusting belts, sheaves, or controls. Parts of the enclosure that would be removed in the performance of these operations and are removable without the use of tools are to be removed to determine whether the ventilator complies with the requirements in 3.5 and 3.6. A warning marking is to be disregarded when determining compliance with these requirements.

3.7 revised March 7, 1996

3.8 The rotor of a motor, pulleys, belts, gears, fan blades, impellers, and the like, of an assembled ventilator shall be enclosed or guarded so as to reduce the risk of injury to persons. See Figure 3.5.

3.8 revised March 7, 1996

3.9 With reference to the requirement in 3.8, the degree of protection required of an enclosure depends upon the general configuration and intended use of the ventilator. Among the factors to be taken into consideration in judging the acceptability of exposed moving parts are:

- a) The degree of exposure,
- b) The sharpness of the moving parts,
- c) The likelihood of unintentional contact with the moving parts,
- d) The speed of moving parts, and
- e) The likelihood of fingers, arms, or clothing being drawn into the moving parts — such as at points where gears mesh, where belts travel onto a pulley, or where moving parts close in a pinching or shearing action.

3.10 An overall enclosure for electrical components of a ventilator intended for outdoor exposure shall have provision for drainage.

4 Mechanical Assembly

4.1 A ventilator shall be assembled so that it will not be adversely affected by the vibration of normal operation. A brush cap shall be tightly threaded or have other provision so that it is unlikely to become loose.

4.2 A switch, lampholder, attachment plug receptacle, motor attachment plug, or similar component shall be mounted securely and shall be prevented from turning or shifting.

Exception No. 1: A switch need not be prevented from turning if all four of 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 forces that tend to rotate the switch during the normal operation of the switch,*
- b) Means of mounting the switch make it unlikely that operation of the switch will loosen it,*
- c) Spacings are not reduced below the minimum acceptable values if the switch rotates, (see Section 15, Spacings) and*
- d) Normal operation of the switch is by mechanical means rather than direct contact by persons.*

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

4.2 revised March 7, 1996

4.3 The means for preventing the turning specified in 4.2 shall consist of more than friction between surfaces. For example, a properly applied lock washer is an acceptable means for preventing a small stem-mounted switch or other component having a single hole mounting means from turning.

4.4 An uninsulated live part shall be secured to the surface on which it is mounted and supporting insulating materials shall be secured in place so that the part will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values specified in Spacings, Section 15.

4.5 Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part; but a properly applied lock washer is acceptable.

4.6 A ventilator shall be completely assembled when shipped from the factory.

Exception No. 1: A ventilator marked in accordance with 30.15 need not be completely assembled when shipped from the factory.

Exception No. 2: A roof mounted or wall mounted ventilator may be shipped from the factory without the motor and drive assembly when all of the following conditions are met.

- a) *The motor is the only electrical load for the ventilator.*
- b) *The motor construction complies with the Standard for Electric Motors, UL 1004.*
- c) *The motor employs thermal protection as referenced in accordance with the Standard for Thermal Protectors for Motors, UL 547, if inherently protected.*
- d) *The motor includes an integral field wiring compartment which complies with the applicable paragraphs of Power Supply Connections, Section 6.*
- e) *The ventilator is marked in accordance with 30.20.*

4.6 revised June 2, 1994

4.7 If a part is shipped disassembled from the ventilator and if it is necessary to make field connections to that part:

- a) The ventilator shall be designed so that it can be permanently connected to one of the wiring systems that would be acceptable for the ventilator;
- 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 spacing;
- c) The information required by 30.17 shall be provided; and
- d) Means for mounting a disconnect switch assembly that is part of the ventilator shall be provided.

4.8 A disconnect switch assembly that is shipped mounted on the ventilator:

- a) Shall be factory-wired to the remainder of the ventilator, or
- b) Shall comply with the requirements in 4.7(a), (b), and (c) and those in 30.17.

5.12 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 water does not enter during the rain 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.

6 Power-Supply Connections

6.1 A ventilator shall be constructed so that it can be permanently connected to one of the wiring systems that would be acceptable for the ventilator.

6.2 An outlet or terminal box in which power-supply connections are to be made shall be located so that such connections may be inspected after the ventilator has been installed as intended.

6.3 An outer cover or panel that must be removed in order to inspect field-wiring connections to a roof- or wall-mounted ventilator shall be constructed so that it may be removed with an ordinary tool, such as a screwdriver or pliers.

6.4 It shall not be necessary to dismount an electrical component or disconnect a duct to gain access to a wiring compartment to inspect field-wiring connections.

6.5 An electrical component shall not be mounted on a part, such as the cover of a wiring-terminal compartment, that must be removed to permit field-wiring connections to be inspected.

Exception: A component that has been investigated and found to be acceptable for such mounting may be mounted on a part that must be so removed.

6.6 A terminal compartment intended for the connection of a power-supply raceway that is mounted to the ventilator shall be attached so as to be prevented from turning with respect thereto.

6.7 A conduit opening in an outer enclosure for power-supply or external-control-circuit connection shall be threaded. The metal at a threaded opening for conduit shall not be less than 1/4 inch thick.

Exception No. 1: A conduit opening need not comply if it is on a duct fan that is not intended for outdoor exposure.

Exception No. 2: A conduit opening need not comply if it is located wholly below the lowest uninsulated live part within the enclosure or if its location prevents drainage into the enclosure.

6.8 If threads for the connection of conduit in the exterior of the enclosure are tapped all the way through the hole in a wall of a box or if an equivalent construction is employed, there shall not be less than 3-1/2 threads nor more than that specified in Table 6.1, and the construction shall be such that a conduit bushing can be properly attached. If threads for the connection of conduit are not tapped all the way through a hole in a wall of a box, conduit hub, or the like, there shall not be less than five full threads in the metal and there shall be a smooth, rounded inlet hole for the conductors that provides protection for the conductors equivalent to that provided by a standard conduit bushing. The opening shall have an internal diameter in accordance with Table 6.2.

6.8 effective June 1, 1994

Table 6.1
Maximum number of threads in a conduit opening

Conduit size, Inch	Number of threads per inch	Maximum number of threads
1/2, 3/4	14	7
1, 1-1/4, 1-1/2, 2	11-1/2	8
2-1/2, 3, 3-1/2, 4	8	9

Table 6.1 effective June 1, 1994

Table 6.2
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)			
			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)	

6.9 The diameter of a knockout shall be such that it will accommodate conduit of the trade size for which the knockout is intended as specified in Table 6.2.

6.10 There shall be a flat surface surrounding a knockout. The flat surface shall have a minimum diameter in accordance with Table 6.2.

6.11 The space provided at terminals or leads intended for the connection of supply conductors, or other conductors to be connected at the time of installation, shall be sufficient for acceptable installation including the accommodation of the necessary splices. A trial installation may be performed to determine compliance with these requirements. (See 6.11.1)

6.11 revised March 7, 1996

6.11.1 An acceptable installation shall:

- a) Be possible using ordinary tools suitable for the installation; and
- b) Not require installed conductors to be forced into contact with uninsulated live parts, or with noncurrent-carrying parts likely to be grounded.

6.11.1 added March 7, 1996

6.12 The area of all open holes in a terminal compartment other than one integral with a motor or as noted in 6.13 shall not be more than 1/4 square inch (160 mm²) in any one side and not more than 3/8 square inch (240 mm²) in the bottom surface. The total area of such holes shall not be more than 1/2 square inch (320 mm²).

6.13 A terminal compartment of a duct fan that is exposed to the main air stream shall not have any open holes.

6.14 The overall enclosure of a roof- or wall-mounted ventilator may serve as the compartment for field-wiring terminals if:

- a) No part that requires service access — an oil hole, belt, or the like — is located in that compartment; and
- b) The total area of openings in the enclosure is not more than 2-1/4 square inches (14.5 cm²) and no slot is wider than 1/32 inch (0.8 mm).

6.15 A ventilator shall be provided with field-wiring terminals for the connection of conductors having an ampacity acceptable for the ventilator; or it shall be provided with acceptable leads for such connection.

6.16 A field-wiring terminal shall be provided with a pressure terminal connector securely fastened in place; for example, firmly bolted or held by a screw.

Exception: A wire-binding screw or stud-and-nut combination may be employed at a wiring terminal intended to accommodate a No. 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

6.17 A field-wiring terminal shall be prevented from turning.

6.18 A wire-binding screw or stud-and-nut combination shall not be smaller than No. 10 (4.8 mm diameter).

Exception No. 1: A No. 8 (4.2 mm diameter) screw may be used at a terminal intended only for connection of a No. 14 AWG (2.1 mm²) conductor.

Exception No. 2: A No. 6 (3.5 mm diameter) screw may be used at a terminal intended only for connection of a No. 16 or 18 AWG (1.3 or 0.82 mm², respectively) control-circuit conductor.

6.19 A wire-binding screw shall thread into a metal terminal plate not less than 0.050 inch (1.27 mm) thick. There shall not be less than two full threads in the metal of the plate.

6.20 A terminal plate formed from stock not less than 0.050 inch (1.27 mm) thick may have the metal extruded at the tapped hole to provide the two full threads for the wire-binding screw.

6.21 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size specified in 6.15 under the head of the screw or washer.

6.22 A field-wiring terminal intended for the connection of a grounded power-supply conductor shall be of or plated with a metal substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

6.23 A lead intended to be connected to a grounded power-supply conductor shall be finished to show a white or natural gray color, and shall be readily distinguishable from the other leads.

6.24 The surface of a lead intended for field connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

6.25 The requirements in 6.22 – 6.24 relating to color coding do not apply to internal wiring that is not visible in a field-wiring compartment.

6.26 The free length of a lead inside an outlet box or wiring compartment shall not be less than 6 inches (152 mm) nor more than 8 inches (203 mm).

Exception: A lead may be less than 6 inches long if it is evident that a longer lead might result in a risk of fire or electric shock.

7 Current-Carrying Parts

7.1 A current-carrying part shall be silver, copper, a copper alloy, or other material acceptable for the application.

7.2 Plated iron or steel may be used for a current-carrying part:

- a) If acceptable in accordance with 2.2.1, or
- b) Within a motor or associated governor;

but the use of iron or steel for current-carrying parts elsewhere in the ventilator is not acceptable.

Exception: Stainless steel may be used anywhere in the ventilator as a current-carrying part.

8 Internal Wiring

8.1 The internal wiring and connections between parts of a ventilator shall be protected or enclosed.

8.2 Type SE, SJE, SJT, SJO, SJOO, SJTO, SJTOO, SO, SOO, ST, STO, STOO cord or appliance wiring material of equivalent construction may be used in a roof- or wall-mounted ventilator without protection other than that provided by the outer enclosure.

8.3 Internal wiring consisting of wire or cord other than that specified in 8.2 shall be enclosed in metal, such as conduit, metal-clad cable, or the like. The assembly shall be mechanically secure and shall provide an electrical bond between parts.

8.4 Internal wiring in a duct fan shall not be exposed to the main air stream, and shall be installed in accordance with the requirements for wiring in ducts in the National Electrical Code, ANSI/NFPA 70-1993.

8.5 Internal wiring consisting of individual insulated conductors – either separate or in a harness – shall be protected as though it were enameled wire in accordance with 3.6.

8.6 The internal wiring and connections of a ventilator shall be acceptable for the application with respect to:

- a) Temperature and voltage,
- b) Exposure to oil, grease, or moisture, and
- c) Other conditions of service to which they are likely to be subjected.

8.7 Type AF or CF wire is not acceptable.

8.8 Wiring shall be protected from sharp edges, screw threads, burrs, fins, moving parts, and other agents that might abrade the insulation on conductors.

8.9 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure of a ventilator shall be provided with a smooth, rounded bushing or shall have a smooth, rounded surface upon which the wires may bear to prevent abrasion of the insulation.

8.10 Insulated wires may be bunched and passed through a single opening in a metal wall within an enclosure.

8.11 Each splice in wiring shall be located, enclosed, and supported so that it is not subject to damage, flexing, motion, or vibration. A splice is considered to be acceptably enclosed when installed in a junction box, control box, or other enclosed compartment in which the wiring materials, as specified in Table 8.1, may be employed. A splice in an enclosed machinery compartment shall be secured to a fixed member in the compartment so that it is not subject to movement or damage during servicing.

8.11 revised March 7, 1996

Table 8.1
Typical wiring materials

Type of wire, cord, or cable ^{a,b}	Wire size		Insulation thickness	
	mm ²	AWG No.	mm	Inch
Thermoplastic appliance wiring material, with insulation thickness shown at the right corresponding to wire sizes indicated; or Type T, TW, or Type ^c AC, ACL, ACT, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, RUH, RUW, THW, XHHW, MTW, THW-MTW, THWN, PF, PGF, PFF, PGFF	5.3 to 0.41	10 to 22	0.8	2/64
	8.4	8	1.2	3/64
	13.3	6	1.6	4/64
	21.2	4	1.6	4/64
	26.7	3	1.6	4/64
	33.6	2	1.6	4/64
	42.4	1	2.0	5/64
	54.0	1/0	2.0	5/64
	67.0	2/0	2.0	5/64
	85.0	3/0	2.0	5/64
	107.2	4/0	2.0	5/64

^a The designated cord or cable, or types of wire other than appliance wiring material, may be used without regard to the values specified in the Table.

^b Type CL wire may be used within a separate material enclosure as leads of components.

^c Wire types included only in the National Electrical Code, ANSI/NFPA No. 70-1990.

Table 8.1 added March 7, 1996

8.12 A soldered connection shall be mechanically secured before being soldered.

8.13 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of spacing between the splice and other metal parts may not be maintained.

8.14 In determining if splice insulation consisting of coated-fabric, thermoplastic, or other type of tubing is acceptable, consideration shall be given to such factors as dielectric properties and resistance to deterioration due to temperature and moisture exposure. Thermoplastic tape wrapped over a sharp edge is not acceptable. An insulated splicing device is acceptable within the limits of its voltage and temperature ratings.

8.15 Wiring shall be located so that it will not be immersed in water as a result of exposure to the weather.

8.16 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will be prevented from contacting other live parts not always of the same polarity as the wire and from contacting dead metal parts. This may be accomplished by using pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other equivalent means.

9 Insulating Material

9.1 Material for mounting uninsulated live parts and for insulating bushings, washers, separators, and barriers shall be porcelain, phenolic composition, or other material acceptable for the application.

9.2 Thermoplastic material may be employed for the sole support of uninsulated live parts if found to have the necessary mechanical strength and rigidity, resistance to flame propagation, dielectric properties, resistance to arcing, thermal endurance, and other properties acceptable for the application.

9.3 A molded part shall be constructed so as to have the necessary mechanical strength and rigidity to withstand the stresses of normal service. Brush caps shall be secured or located so as to be protected from damage that might occur during use.

10 Motors

10.1 General

10.1.1 A motor shall be acceptable for the application and shall be capable of driving the maximum normal load of the ventilator without introducing a risk of fire, electric shock, or injury to persons.

10.2 Enclosure

10.2.1 A roof- or wall-mounted ventilator motor that is exposed to the main air stream shall be totally enclosed.

Exception: A roof- or wall-mounted ventilator that is marked in accordance with 30.16 may employ a motor of other than the totally enclosed type if the motor is provided with inherent overtemperature protection complying with the requirements for running and locked-rotor protection.

10.2.2 A duct-fan motor that is exposed to the main air stream shall be totally enclosed. See 8.4.

10.3 Protection

10.3.1 A ventilator employing a motor that must be cooled by the main air stream to prevent overheating when operating continuously — an air-over motor — shall incorporate automatically reset inherent overtemperature protection.

10.3.2 For a ventilator employing a motor other than as described in 10.3.1, automatically reset thermal or overcurrent motor protection shall be incorporated in the ventilator.

Exception: A ventilator that is marked in accordance with 30.6 need not have thermal or overcurrent motor protection. This exception does not apply to the requirements in 10.2.1.

10.3.3 A motor provided with inherent overtemperature protection complying with the Standard for Thermal Protectors for Motors, UL 547, is considered to comply with the requirements in 10.3.1 and 10.3.2. A motor used with a direct-drive fan or blower need comply only with the requirements for protection during locked-rotor conditions.

10.3.4 Table 10.1 summarizes the requirements relating to motor protection.

Table 10.1
Summary of motor-protection requirements

Motor location	Motor type	Type of fan drive	Minimum type of inherent protection required ^a
Exposed to main air stream	Open ^{b,c}	Any	Automatically reset, running and locked-rotor
Exposed to main air stream	Totally enclosed air-over	Belt	Automatically reset, running and locked-rotor
Exposed to main air stream	Totally enclosed air-over	Direct	Automatically reset, locked-rotor
Not Exposed to main air stream	Open or totally enclosed	Belt	Automatically reset, running and locked-rotor ^d
		Direct	Automatically reset, locked-rotor ^d

^aSee 30.5 for required marking.

^bIf marked in accordance with 30.16.

^cSee 10.2.2.

^dSee Exception to 10.3.2.

15.2 Other than at field-wiring terminals, the spacing between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall not be less than that specified in Table 15.2. If an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the minimum acceptable spacings will be maintained.

Exception: This requirement does not apply to the inherent spacings of a component of the ventilator such as a snap switch. Such spacings are judged on the basis of the requirements for the component in question.

Table 15.2
Spacings at other than field-wiring terminals or in motors

Potential Involved, volts	Minimum spacings, Inch (mm)			
	In ventilators employing a motor 7 inches (180 mm) or less in diameter ^a		In ventilators employing a motor more than 7 inches in diameter ^a	
	Over Surface	Through Air	Over Surface	Through Air
0 – 125	3/32 (2.4) ^b	3/32 (2.4) ^b	1/4 (6.4) ^c	1/8 (3.2) ^c
126 – 250	3/32 (2.4)	3/32 (2.4)	1/4 (6.4) ^c	1/4 (6.4) ^c
251 – 600	1/2 (12.7) ^c	3/8 (9.5) ^c	1/2 (12.7) ^c	3/8 (9.5) ^c

^aThis is the diameter, measured in the plane of laminations of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connection.

^bIn a ventilator employing a motor rated at 1/3 horsepower (250 W output) or less, these spacings may be not less than 1/16 inch (1.6 mm).

^cFilm-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch over surface and through air between film-coated wire rigidly supported and held in place on a coil and a dead metal part is acceptable in a ventilator rated at more than 250 volts or employing a motor having a diameter of more than 7 inches. See note a.

15.3 The spacings for a motor shall comply with the spacing requirements in the Standard for Electric Motors, UL 1004.

15.4 In applying 15.2, 15.3, 21.1, and note b in Table 15.2 to an appliance employing a motor not rated in horsepower (W output), use is to be made of the appropriate table of the National Electrical Code, ANSI/NFPA 70-1993, that gives the relationships between horsepower and full-load currents for motors.

15.5 At terminal screws and studs to which field connection may be made using wire connectors, eyelets, and the like as described in 2.1.3, opposite polarity spacings and spacings to dead metal shall not be less than as specified in Table 15.2 with the connectors, eyelets, and the like installed in such position that minimum spacings exist.

15.6 An insulating lining or barrier of vulcanized fiber or similar material employed in lieu of spacings shall be at least 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it will not be adversely affected by arcing.

Exception: Vulcanized fiber not less than 1/64 inch (0.4 mm) thick may be used in addition to an air spacing of not less than 50 percent of the minimum acceptable through air spacing.

15.7 Materials and combinations of materials other than those specified in 15.6 may be used if they have been found to be acceptable based on an investigation of their ability to resist degradation due to:

- a) Temperature,
- b) Vibration,
- c) Thermal cycling, and
- d) High humidity.

16 Filters

16.1 A filter shall be a Class 1 or Class 2 filter.

16.2 A Class 1 filter is one that, when clean, does not contribute fuel when attacked by flame and emits only negligible amounts of smoke. A Class 2 filter is one that, when clean, burns moderately when attacked by flame, emits moderate amounts of smoke, or both.

PERFORMANCE

17 Starting Current Test

17.1 A ventilator shall start and attain normal running speed without opening a fuse when energized on a circuit protected by a fuse of other than the time-delay type. The fuse is to have a current rating corresponding to that of the motor branch circuit to which the ventilator may be connected in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

Exception: If a ventilator is marked in accordance with 30.13, it shall start and attain normal running speed without opening a fuse on a circuit protected by a time-delay fuse.

17.2 The ventilator is to be started three times when connected to a circuit of minimum rated voltage. Each start of the motor is to be under conditions representing the beginning of normal operation. The motor is to be allowed to come to rest between starts, and is to be restarted immediately. Opening of an overload-protective device provided as part of the ventilator after the first start is acceptable.

18 Input Test

18.1 The current input to a ventilator shall not be more than 110 percent of the rated value when the ventilator is operated under conditions of actual service and connected to a supply circuit of maximum rated voltage and rated frequency.

18.2 Unless otherwise specified, each ventilator is to be tested at the appropriate potential indicated in Table 18.1, for each test as detailed in the applicable sections.

18.2 revised March 7, 1996

Table 18.1
Test voltage

Unit rated voltage	Test voltage ^a
110 – 120	120
200 – 208	208
220 – 240	240
254 – 277	277
440 – 480	480
550 – 600	600
Other	Rated
^a Tolerance $\pm 2\%$.	

Table 18.1 added March 7, 1996

18.3 For the input test, the ventilator is to be connected to a fitting or structure that can be adjusted to uniformly restrict the air supply. The structure may consist of an inlet duct, with or without air straighteners, connected to the ventilator or to a plenum on which the ventilator is mounted and arranged to avoid undue turbulence of air supply.

27 Bonding Connection Test

27.1 The bonding connection between grounded metal and the motor frame shall not open when carrying for 2 minutes a current equal to twice the rated current of the fuse of largest current rating that can be mounted in the fuseholder of the branch circuit to which the ventilator would normally be connected.

Exception: This test need not be conducted if the minimum bonding conductor is:

- a) Sized in accordance with Table 250-95 of the National Electrical Code, NFPA 70; or
- b) Not smaller than one of the power supply conductors.

27.1 revised March 7, 1996

MANUFACTURING AND PRODUCTION TEST

28 Production Dielectric Voltage-Withstand Test

28.1 Each ventilator shall withstand without electrical breakdown as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 hertz:

- a) Between the primary winding, including connected components, and accessible dead metal parts that are likely to become energized, and
- b) Between primary wiring and accessible low-voltage (42.4 volts peak or less) metal parts, including terminals.

Exception: A ventilator that has no electrical components other than a motor that is acceptable for permanent connection to the power supply, and that has been found to comply with the production dielectric voltage-withstand requirement in the Standard for Electric Motors, UL 1004, need not be subjected to this test.

28.2 The production-line test shall be in accordance with either condition A or condition B of Table 28.1.

Table 28.1
Production-line test conditions

Appliance rating	Condition A		Condition B	
	Potential, volts	Time, seconds	Potential, volts	Time, seconds
250 volts or less with no motor rated more than 1/2 horsepower (370 W)	1000	60	1200	1
More than 250 volts or with a motor rated more than 1/2 horsepower	$1000 + 2V^a$	60	$1200 + 2.4V^a$	1
^a Maximum marked voltage.				

28.3 The ventilator may be in a heated or unheated condition for the test.

28.4 The test shall be conducted when the ventilator is fully assembled. It is not intended that the ventilator be unwired, modified, or disassembled for the test.

Exception No. 1: A part such as a snap cover or a friction-fit knob that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be conducted before final assembly if the test represents that for the completed ventilator.

28.5 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature of any unacceptable unit.

28.6 If the output of the test equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

28.7 If the output of the test-equipment transformer is 500 volt-amperes or larger, the test potential may be indicated:

- a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,
- b) By a selector switch marked to indicate the test potential, or
- c) In the case of equipment having a single test-potential output, by a marking in a visible location to indicate the test potential.

When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

28.8 Test equipment other than that described by 30.6 and 30.7 may be used if found to accomplish the intended factory control.

28.9 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the ventilator are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal parts that are likely to become energized.

RATING

29 Details

29.1 A ventilator shall be rated in:

- a) Volts.
- b) Amperes.

Exception: The rating may be in watts if the full-load power factor is 0.80 or more.