UL 507

STANDARD FOR SAFETY

Electric Fans

UL Standard for Safety for Electric Fans, UL 507

Tenth Edition, Dated November 9, 2017

Summary of Topics

The revisions for ANSI/UL 507 dated August 24, 2023 include the following changes in requirements:

– Alternate insulation; 144.1.1, 144.1.3, 144.1.6, 144.1.6A, 144.1.12, Figure 144.0

– Remote safety software update requirements; SA2.7

– Ducted fans to the outside; 83.10

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated April 29, 2022 and July 7, 2023.

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The most recent designation of ANSI/UL 507 as an American National Standard (ANSI) occurred on August 24, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 507 on February 5, 1993. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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PART 1 – ALL FANS

INTRODUCTION

1 Scope

1.1 These requirements cover:

a) Fans and blowers that circulate air, such as desk, ceiling-suspended, and hassock fans;

b) Fans and blowers that ventilate air, such as attic, whole-house window, through wall, and direct discharge fans;

c) Ducted fans and blowers that exhaust air to the outside of a building structure, such as in-line, wall insert and ceiling insert fans;

d) Dryer type fans used for drying carpets or floors;

e) Commercial display blowers;

f) Evaporative coolers;

g) Evaporative cooler replacement pumps;

h) Air-filtering appliances;

i) Component fans;

j) Low voltage component fans;

k) Residential cooking area fans, such as rangehoods and downdrafts;

l) Hand dryers without heater; and

m) Recirculating and blending units except as noted in 1.2(h).

These products are rated 600 volts or less and are intended to be employed in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements do not cover:

a) Air heaters incorporating fans, heating-ventilating units, or blowers comprising components of such equipment as furnaces, mechanical-refrigeration equipment, or air conditioners;

b) Fusible links, and the like, provided to disconnect a fan or close shutters in the event of fire;

c) Fans for use in cooking areas when the fan is intended for other than household use;

d) Fans intended to be used in hazardous locations as defined in the National Electrical Code, ANSI/NFPA 70;

e) Fans intended to be installed over solvents or chemically flammable liquids or vapors;

f) Fans located in chemically corrosive environments;

g) Humidifiers;

h) Fans intended to move heated or conditioned air;

i) Heated hand dryers;

j) Ionizers, products with ionization features, or electrostatic air cleaners;

k) Household or commercial blowers or inflators intended for use with inflatable bouncing toys or similar children's products.

l) Microwaves, ventilating or otherwise;

m) Ducted or non-ducted heat recovery ventilators;

n) Deodorizers and air fresheners.

2 Glossary

2.1 General

2.1.1 For the purpose of this standard the following definitions apply. The types of appliances are arranged in alphabetical order under the heading Product Terms. Other terms not related to the types of products are defined in alphabetical order under the heading Additional Terms. Also, see appropriate sections of the Standard for specific fan types not defined in this section.

2.2 Product terms

2.2.1 AIR-FILTERING APPLIANCE – An appliance consisting of an air-circulating fan and a mechanical filter.

2.2.2 AIR DEODORIZER – An appliance that has a fan and is intended to treat the air in a relatively small area by the dispersal of chemicals. A mechanical filter may be employed.

2.2.3 AIR FRESHENER – An appliance that has a fan and is intended to scent the air in a relatively small area by the dispersal of chemicals. A mechanical filter may be employed.

2.2.4 ATTIC FAN – A fan mounted on a building's roof or gable used to vent air out from the attic to the exterior of the building. Exhaust of the fan is typically capped with a dome lid or behind louvres to prevent exposure to weather.

2.2.5 BLADE – A component of an impeller or an individual "paddle" of a ceiling-suspended fan.

2.2.6 BOX FAN – A portable fan sometimes referred to as a "suitcase" fan. This product consists of a front and back grill mounted to a central frame, typically rectangular or square in shape, with width and height dimensions each measuring greater than 16 inches. The fan is typically designed to be placed on the floor or desk during operation, but may be provided with hardware for window mounting.

2.2.7 CEILING INSERT FAN/LIGHT COMBINATION – An appliance consisting of a fan and a light which is installed through a hole in the ceiling surface.

2.2.8 CEILING-SUSPENDED FAN – A fan intended to be mounted to a ceiling outlet box or ceiling building structure, and has blades which rotate below the ceiling. Popularly called a "paddle" fan.

2.2.9 DESK FAN – A fan intended for use on a desk or table. Some desk fans are provided with keyhole slots for wall mounting.

2.2.10 DOWN-DRAFT FAN – A fan intended for installation adjacent to a grill or stove top, and that draws smoke down into an exhaust duct.

2.2.11 DRAIN PUMP – A pump provided in an evaporative cooler, in addition to the recirculating pump(s), intended to periodically purge the reservoir of mineral laden water.

2.2.12 EVAPORATIVE COOLER (also referred to a swamp cooler or desert cooler) – An appliance used to lower the temperature and increase the humidity of air by using latent heat of vaporization, changing liquid water to water vapor. The evaporative cooler unit uses a fan to draw air through a wetted membrane, or pad, which provides a large surface area for the evaporation of water into the air. This appliance incorporates a fan, filter, or heater, or all of these components. Some evaporative coolers have provision for connection to a duct.

2.2.13 FLOOR INSERT FAN – An intake or exhaust fan installed in a raised floor.

2.2.14 HASSOCK FAN – A floor support fan resembling a foot rest.

2.2.15 COMMERCIAL DISPLAY BLOWER – Blower intended for use with commercial displays possessing an outlet intended to be exposed to normal atmosphere.

2.2.16 IMPELLER – An assembly of blades about an integral hub.

2.2.17 THROUGH-WALL FAN – A fan installed through the wall or other structure and intended to draw air from the outside or exhaust air from the inside.

2.2.18 LOW VOLTAGE COMPONENT FAN – A component fan intended to be used in isolated secondary circuits and rated a maximum of 30 V rms (42.2 V peak) or 60 V dc.

2.2.19 OUTER SHELL – A continuous casing which collects the air and guides the air stream towards the duct system of the building in case of exhaust installation, or towards the point(s) where the cleaned air is discharged back into the room in case of recirculating installation.

Note: The air intake and the air discharge are not considered as openings in the outer shell.

2.2.20 PORTABLE APPLIANCE – A cord-connected appliance capable of being easily moved by hand from place to place (in normal use).

2.2.20.1 PRIMARY PROTECTION – A protector that does operate during the Locked Rotor (abnormal operation) Test of Section 50.

2.2.21 ROOM-TO-ROOM FAN – An appliance that is to be installed in a sleeve through an interior wall, and is intended to direct air from one room to another.

2.2.22 SECONDARY PROTECTION (BACK-UP PROTECTION) – A thermal cutoff, manual reset thermal protector, or supplemental-fuse overcurrent protection provided as part of a motor or fan assembly that does not operate during the Locked Rotor Test of Section 50.

2.2.23 STATIONARY APPLIANCE – A cord-connected appliance that is intended to be fastened in place or located in a dedicated place.

2.2.24 VENTILATING-HOOD-FAN SHELF – A hood fan incorporating a shelf or a compartment to accommodate a microwave oven.

2.2.25 WALL-INSERT FAN – An intake or exhaust fan permanently attached in a wall without a sleeve.

2.2.26 WHOLE HOUSE FAN – A fan mounted on the attic-side of a ceiling, typically centrally located in a hallway. The fan is usually concealed behind a ceiling grill that opens and closes automatically. The fan is used to cool an entire house by drawing cooler outside air through open windows in the house and exhausting the hot room air through the attic to the building exterior.

2.2.27 WINDOW-MOUNTED FAN – A window fan or a box fan intended for installation in a window.

2.3 Additional terms

2.3.1 AIR DISTRIBUTION SYSTEM – For the purpose of determining smoke developed requirements for non-metallic enclosures and other parts of appliances covered by this Standard, an air distribution system is defined as a continuous passageway for the transmission of air that does not vent directly to the outdoors. For example, a building having several fans inter-connected with air ducts before venting to the outdoors.

2.3.2 APPLIANCE COUPLER – A single-outlet, female contact device that is attached to a flexible cord as part of a detachable power supply cord to be connected to an inlet.

2.3.3 ASKAREL – A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

2.3.4 BRANCH CIRCUIT, INDIVIDUAL – A branch circuit that supplies only one utilization equipment.

2.3.5 CABINET – That part of a unit that encloses insulated wiring, electrical enclosures, moving parts, motors, or enclosed electrical parts.

2.3.6 CONVENIENCE RECEPTACLE – Receptacle intended for the connection of an independent appliance or product.

2.3.7 COOKING AREA – An area in close proximity (as defined in Figure 80.1) to a stove, range, or oven, where fumes, grease laden air, or the like may be present.

2.3.7A DUCT-CONNECTION ADAPTOR – An assembly for the transition between the integral duct-connection fitting of fans for use in cooking areas and the ductwork of the building, often provided to accommodate different size or shape duct configurations.

2.3.8 ELECTRONICALLY PROTECTED MOTOR – A motor that relies upon an electronic circuit to prevent overheating of the motor. The motor is defined as the combination of the motor coil and the associated control and/or power supply that is required for proper motor operation.

2.3.9 ENCLOSURE – That part of the product that:

a) Renders inaccessible all or any parts of the fan that present a risk of electric 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; or

b) Retards propagation of flame initiated by electrical disturbances occurring within.

2.3.10 INLET – A male contact device that is mounted on a fan to provide an integral blade configuration for the connection of an appliance coupler.

2.3.10A INTEGRAL DUCT-CONNECTION FITTING – The part of a fan for use in cooking areas that provides transition between the outer shell and ductwork of the building. It can be part of the assembled appliance when it leaves factory, or shipped disassembled from the appliance.

2.3.11 MOUNTING MEANS – Hardware to mount the fan to the building structure or to an outlet box.

2.3.12 OPERATING CONTROL – A device or circuit, the operation of which, starts or regulates the appliance during normal operation.

Note: Examples of operating controls include motor controls not relied upon for overtemperature protection under normal and abnormal operating conditions.

2.3.13 OTHER SPACE USED FOR ENVIRONMENTAL AIR – Space used for environmental air-handling purposes other than ducts and plenums. It does not include habitable rooms or areas of buildings, the prime purpose of which is not air handling. The space over a hung ceiling used for environmental air handling purposes is an example of the type of other space to which this section applies.

2.3.14 OUTLET BOX – As used in this standard, the term "outlet box" includes an outlet box or any other supporting system, usually field supplied, intended to enclose splices and wiring devices or to support a fan.

2.3.15 PROTECTIVE CONTROL – A device or circuit, the operation of which is intended to prevent a hazardous situation during abnormal operation of the machine or equipment.

2.3.16 RISK OF ELECTRIC SHOCK – A risk of electric shock exists at any part when:

a) The potential between the part and earth ground or any other accessible part is more than 30 V rms (42.4 V peak); and

b) The continuous current flow through a 1500 ohm resistor connected across the potential exceeds 0.5 mA.

2.3.17 SINGLE-OPERATION DEVICE – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and is resettable only by cooling to minus 35°C (minus 31°F), or lower.

2.3.18 SPECIAL-USE RECEPTACLE – Receptacle intended for the connection of a specific component of the end-product appliance.

2.3.19 TOTALLY ENCLOSED MOTOR – A motor that is enclosed to prevent the free exchange of air between the inside and outside of the enclosure for windings but not sufficiently enclosed to be airtight. Drainholes are acceptable.

2.3.20 USABLE NORMAL CONDITION – Operation in excess of 25 rpm for ceiling suspended fans and operation at 10% or greater of measured as-received high speed rpms for all other fans, excluding fans for use in unattended areas.

Exception No. 1: An increase in volume or change in pitch of noise emitted from the fan is considered to signify an abnormal condition.

Exception No. 2: Operation of a motor thermal protector prior to temperature stabilization is considered to signify an abnormal condition.

2.3.21 USER SERVICING – Any form of servicing, such as routine cleaning and replacement of a fuse or a lamp, that is performed by personnel other than those trained to maintain the appliance.

2.3.22 VENTURI – A constricting throat in the air passage of an appliance which causes a pressure differential.

3 Units of Measurement

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

3.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are root mean square (rms).

4 Undated References

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.

5 Application of Requirements

5.1 This standard is comprised of two parts. Part 1 consists of requirements that are to be applied to all products covered by UL 507 unless otherwise specified. Part 2 consists of requirements for specific product types. These requirements supplement or modify the requirements in Part 1. For each product type, the requirements unique to that construction are presented in the same format as Part 1 (with headings for construction, performance, marking, and the like). A product's construction and intended use may result in the application of more than one set of requirements in Part 2. (For example: a ceiling-suspended fan intended for use in an agricultural environment shall comply with the requirements in Part 1, the requirements for ceiling-suspended fans in Part 2, and the requirements for fans used in agricultural buildings in Part 2.)

5.2 With respect to the text in this Standard, a requirement that applies only to a specific type of appliance, such as an evaporative cooler or an air-filtering appliance, is so identified by a specific reference in that requirement to the type involved. Absence of such specific reference, or use of the term "appliance" or "fan", indicates that the requirement applies to all appliances covered by this Standard unless the context indicates otherwise.

5.3 A household canopy- or hood-type unit, the electrical components of which are complete except for a fan or blower, may be investigated under the applicable requirements in this standard to determine whether the unit is acceptable for use with cooking equipment. A household wall- or ceiling-insert fan that is intended for use with such a separate hood may also be investigated to determine whether it is acceptable for use with cooking equipment. See 80.5.1 and 112.1.

5.4 A combination fan and light combination or a ceiling-suspended fan light kit shall comply with the applicable requirements of this standard and with the applicable requirements in the Standard for Luminaires, UL 1598.

5.5 An evaporative cooler that incorporates a heating element is investigated in accordance with the applicable requirements of this standard and with the applicable requirements for electric space-heating equipment.

CONSTRUCTION

6 Components

6.1 General

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

a) Comply with the requirements for that component as indicated in 6.2 – 6.10 or the individual component section;

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.

Note – 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.

Exception No. 1: A lamp is not required to comply with the requirements for mercury.

Exception No. 2: A component of a product covered by this standard is not required to comply with a specific component requirement that:

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

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. 3: A component complying with a UL component standard other than those cited in 6.2 – 6.10 or the individual component section is acceptable if:

a) The component also complies with the applicable component standard of 6.2 – 6.10 or the individual component section; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements of the National Electrical Code, ANSI/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.

6.1.2 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.

6.1.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of 6.2 – 6.10 or individual component sections 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 6.1.1 (b) – (d).

6.1.4 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.

6.2 Attachment plugs, receptacles, connectors, and terminals

6.2.1 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. See 6.2.9.

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

6.2.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 3.5, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 in), 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 UL 310.

6.2.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory connection and 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 Use in Data, Signal, Control and Power Applications, UL 1977. See 6.2.9.

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

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

6.2.6 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings or that are intended for consumer connection within and between parts of electrical equipment, shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459. See 6.2.9.

6.2.7 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.

6.2.8 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

6.2.9 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 suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

Exception: This requirement is not intended to address those connectors required by 19.17.

6.3 Boxes and raceways

6.3.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of the National Electrical Code, ANSI/NFPA 70 and that comply with the relevant UL standard (such as the Standard for Metallic Outlet Boxes, UL 514A, Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D) and 6.1 are considered to fulfill the requirements of this Standard.

6.4 Cords, cables, and internal wiring

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

6.4.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a cord set or power supply cord complying with the Standard for Cord Sets and Power Supply Cords, UL 817.

6.4.3 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 UL 758 if they comply with one of the following:

a) Standard for Thermoset-Insulated Wires and Cables, UL 44;

b) Standard for Thermoplastic-Insulated Wires and Cables, UL 83;

c) Standard for Fixture Wire, UL 66; or

d) The appropriate UL standard(s) for other insulated conductor types specified in Chapter 3 (Wiring Methods and Materials) of the National Electrical Code, ANSI/NFPA 70.

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 UL 758.

6.5 Cord reels

6.5.1 A cord reel shall comply with the special-use cord reel requirements of the Standard for Cord Reels, UL 355.

6.6 Light sources and associated components

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

Exception: Lampholders forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

6.6.2 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 an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Ballasts for other light sources shall comply with the appropriate UL standard(s).

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

Exception No. 1: LED light sources forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with UL 8750, but shall comply with the applicable requirements of this end product standard.

6.7 Overcurrent protection

6.7.1 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable UL 248 Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate UL standard for the fuse are considered to fulfill this requirement.

6.7.2 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with UL 489.

6.7.3 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

6.7.4 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

6.7.5 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

6.8 Power supplies

6.8.1 A Class 2 power supply shall comply with one of the following:

a) Standard for Class 2 Power Units, UL 1310;

b) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 that complies with the limited power source (LPS) requirements and is marked "LPS"; or

c) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, that complies with the limited power source requirements (LPS) requirements and is marked "LPS".

6.8.2 A non-Class 2 power supply shall comply with one of the following:

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; or

c) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

6.9 Supplemental insulation, insulating bushings, and assembly aids

6.9.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill a requirement of this standard. In such cases:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510, or for tapes requiring greater than 80 C rating, the Standard for Component Tapes, UL 510A;

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.

6.9.2 Insulating bushings that comply with Section 6.1 of this end-product standard, and the Standard for Insulating Bushings, UL 635, are considered to fulfill the 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 part are suitable.

6.10 Transformers

6.10.1 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 when tested in conjunction with the end product, 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.

6.10.2 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.

7 Frame and Enclosures

7.1 General

7.1.1 An appliance shall be formed and assembled so that it has the strength and rigidity necessary to resist the abuses to which it is subjected, without causing 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 is not required to 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 shall not be thinner than the specifications in the first column of thicknesses in Table 7.1 unless such factors as the following are determined to be 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 7.1
Minimum thicknesses of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength		At surfaces to which a wiring system is to be connected in the field		At large, unreinforced, flat surfaces	
	mm	(inch)	mm	(inch)[a]	mm	(inch)
Die-cast metal	1.19	(3/64)	–		1.98	(5/64)
Cast malleable iron	1.59	(1/16)	–		2.38	(3/32)
Other cast metal	2.38	(3/32)	–		3.18	(1/8)
Uncoated sheet steel	0.66	(0.026)	0.81	(0.032)	0.66	(0.026)
Galvanized sheet steel	0.74	(0.029)	0.86	(0.034)	0.74	(0.029)
Nonferrous sheet metal	0.91	(0.036)	1.14	(0.045)	0.91	(0.036)

[a] A sheet-steel wall of thickness less than that specified shall not be used unless the area surrounding the knockout has a minimum thickness of 0.81 mm (0.032 inch).

7.1.3 A fan having features intended to be attractive to children or to have play value or an appearance of play value shall:

a) Be provided with a marking that warns against use as a toy as described in 81.6; and

b) Not have any portion of the fan intended to be removed and utilized as an item with play value.

Exception: This requirement does not apply to a fan that complies with the Standard for Electric Toys, UL 696.

7.1.4 The enclosure of an appliance shall prevent molten metal, burning insulation, flaming particles, and other ignited material from falling onto flammable materials, including the surface upon which the appliance is supported when the appliance is:

a) Installed in a remote location such as the location of an attic ventilator or a whole house ventilator; or

b) Thermostatically controlled.

Exception: This requirement does not apply to a thermostatically controlled fan intended for use in cooking areas and mounted directly above the cooking surface.

7.1.5 The requirements in 7.1.4 necessitate the use of a metal barrier or a non-metallic barrier of a material having a zero flame spread rating when tested as described in 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 (such as the use of metal louvers as bottom barriers);

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 prevents the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor runs without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked; or

Exception: A direct drive fan motor is required to 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 1004-2, and the temperature of the motor winding does not exceed 150°C (302°F) during the first 72 hours of operation with the rotor of the motor locked.

b) Under wire, unless the wire:

1) Complies with the requirements of the Vertical Wires test in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581, and is 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 similar component unless:

1) A short circuit or overload in the component does 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 other ignited material can fall.

Exception: A terminal is not required to have a barrier.

7.1.6 The barrier mentioned in 7.1.5 shall be horizontal, shall be located as illustrated in Figure 7.2, and shall have an area in accordance with the illustration. Openings for drainage, ventilation, and the like, shall not be employed in the barrier unless such openings do not permit molten metal, burning insulation, or similar material, to fall onto flammable material.

7.1.7 A ventilating opening provided in the enclosure of an appliance or an externally mounted component of an appliance where the appliance is intended to be recessed into a wall or false ceiling shall not vent into a concealed space where the spread of a fire occurs undetected.

7.2 Wood enclosure parts

7.2.1 Wood shall not be employed as an appliance enclosure unless:

a) The enclosure is not intended for use in a cooking area, a bathroom, a damp location, or outdoors; and

b) The enclosure is in accordance with the Temperature Test requirements in Table 46.1, as applicable to wood.

7.2.2 A wood enclosure serving as an enclosure of uninsulated live parts shall be subjected to flammability testing and resistance to impact testing (5 ft-lbs) in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.3 Non-metallic enclosures

7.3.1 A non-metallic enclosure shall comply with the applicable mechanical and electrical property considerations, flammability, and thermal requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A 6.8 J (5 ft·lbf) impact value shall apply to all appliances when determining the impact resistance of polymeric enclosures in the as-received condition. This impact value shall also be used for cold impact testing of appliances intended to be used in cold environments, such as fans mounted in the crawl space or attic and outdoor use products.

Exception No. 1: A polymeric grille used in a ceiling or wall insert fan is not required to comply with the flammability requirements of UL 746C when:

a) The material has a minimum flame class rating of HB;

b) All live parts within the enclosure are insulated and the insulation thickness is 0.71 mm (0.028 inch) or greater; and

c) The grille is completely external when installed as intended.

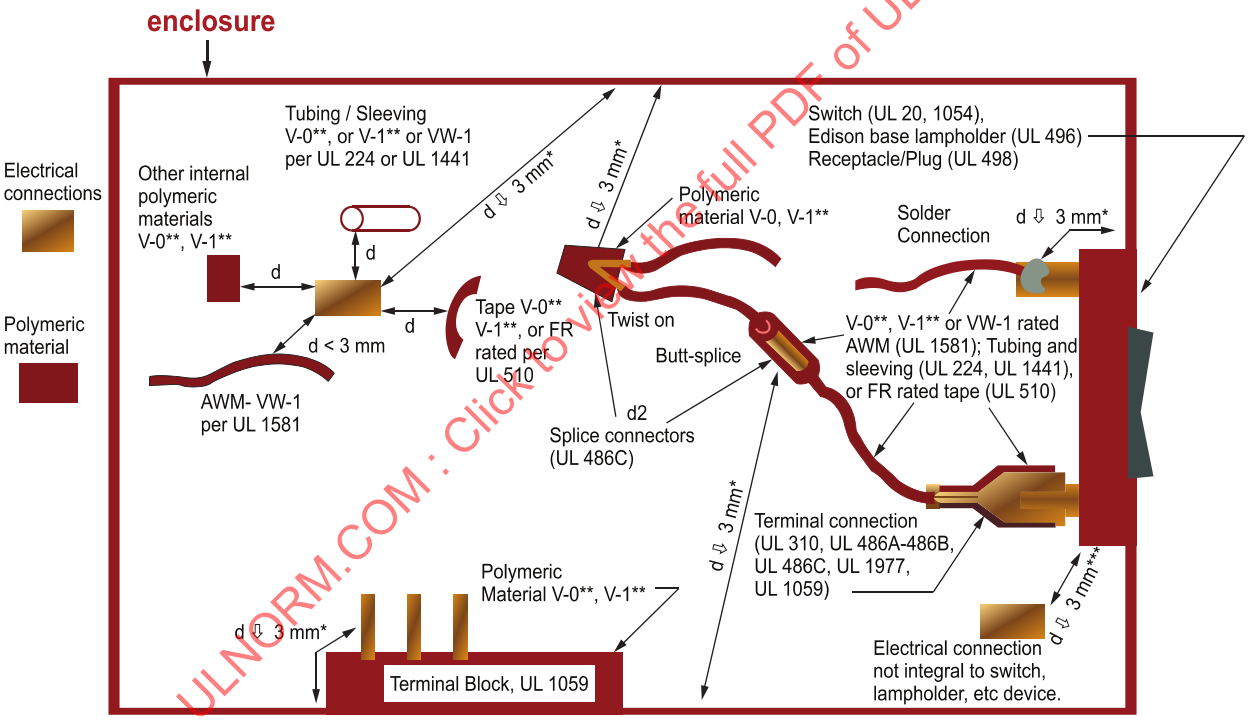
Exception No. 2: A polymeric grille used in a fan intended to be mounted at least 2.1 m (7 feet) above the floor is not required to comply with the Resistance to Impact Test of UL 746C.

Exception No. 3: Compliance with the pullout, torque, and bending tests of footnote i, Table 4.1, of UL 746C is not required for permanently connected products provided with the installation instruction of 83.11.

7.3.2 Section 5 of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, includes an additional set of requirements for Portable Unattended Household Equipment that may be applied to portable fans. Figure 7.1 depicts figuratively the construction requirements for these products. In addition, products evaluated to this set of requirements shall comply with the Severe Conditions Test in accordance with 28.1, Mold Stress Relief Distortion Test, in accordance with Subsection 29.1 (utilizing conditioning guidelines as outlined in Subsection 61.2) and Input to Motor (after Mold-Stress Relief Distortion) in accordance with Subsection 30.1 of UL 746C.

Figure 7.1

Alternate path



su1918

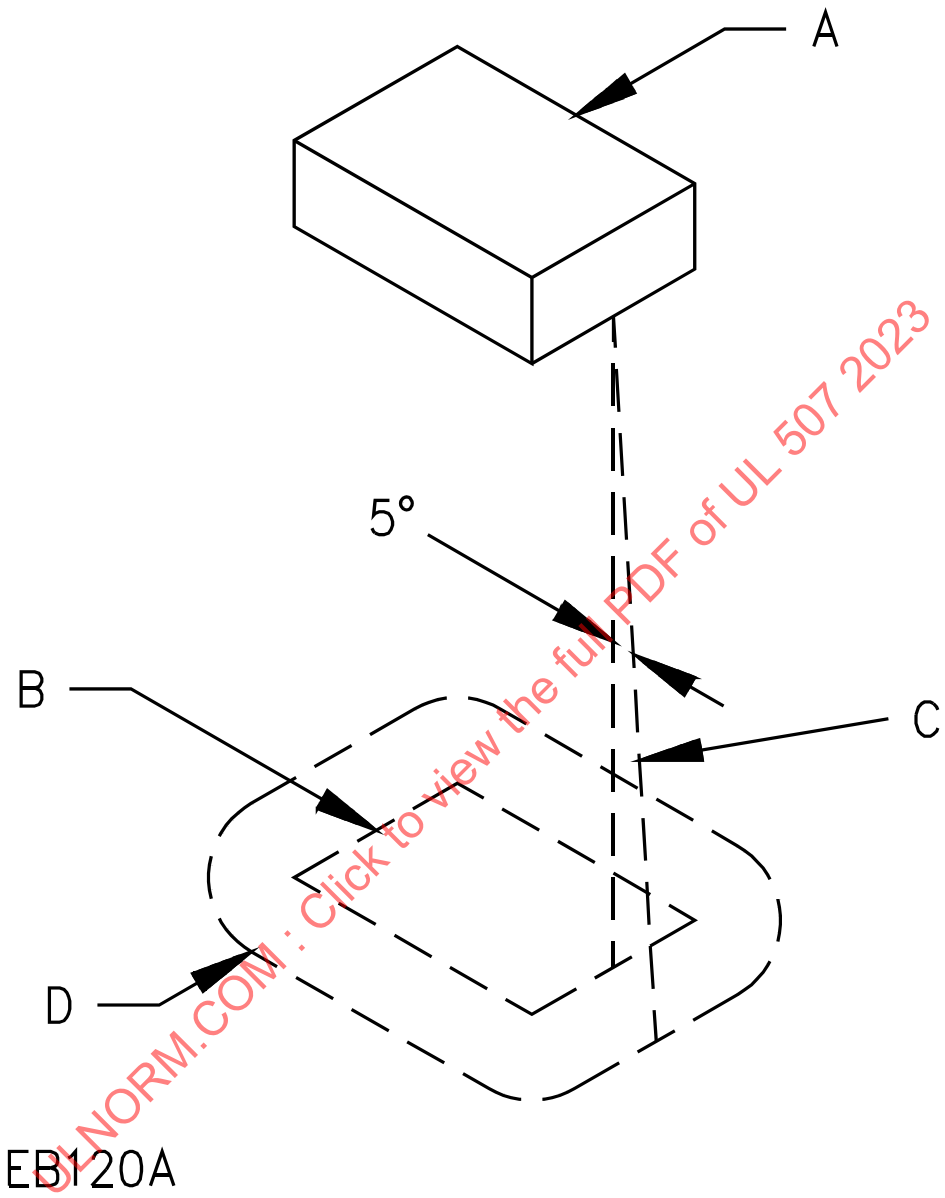
* Or, enclosure min 750°C (1382°F) GWIT and 750°C (1382°F) GWFT; or pass GWEPT

** Alternatively, VTM-0, VTM-1, SC-0, SCTC-0, or SCTC-1; or min 750°C (1382°F) GWIT and 750°C (1382°F) GWFT; or GWEPT

*** Or switch, lampholder, etc. material V-0, V-1, VTM-0, VTM-1, SC-0, SC-1, SCTC-0, or SCTC-1 or min 750°C (1382°F) GWFT; or GWEPT

Figure 7.2

Barrier



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.

7.3.3 When conducting the Severe Conditions Test in accordance with 28.1 of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, motor protection in accordance with 23.1 (a) and (c) may be retained in the circuit.

7.3.4 Among the factors to be considered when judging a non-metallic enclosure, other than of polymeric material, or a magnesium enclosure shall be:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to arcing; and

f) Resistance to distortion at temperatures to which the enclosure is subjected under conditions of normal or abnormal use.

7.3.5 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. 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.

7.3.6 A non-metallic enclosure of a fan employing a fluorescent light shall comply with the requirements of 167.3, Exposure to sunlight (ultraviolet radiation).

Exception: A polymeric enclosure that complies with the Ultraviolet Light Exposure Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, does not need to comply with the requirements of 167.3, Exposure to sunlight (ultraviolet radiation).

7.3.7 A wall or ceiling insert fan or ceiling insert fan/light combination that is provided with a polymeric housing shall be marked not for use in fire rated installations and for use in one- and two-family dwellings only, in accordance with 80.5.7 and 80.5.8.

7.4 Non-metallic parts other than enclosures

7.4.1 Polymeric material used to enclose a metal housing that encloses insulated or uninsulated live parts, or used as a decorative part, shall be classed either 5VA, 5VB, V-0, V-1, V-2, or HB by the burning tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 1: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB when the part does not occupy a volume greater than 2 cubic centimeters (0.122 cubic inch), does not have any dimension greater than 3 cm (1.18 inch), and is located so it does not propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

Exception No. 2: A material is determined to be equivalent when it complies with the 12-mm (0.47 inch) flame test, the 19-mm (0.75-inch) flame test, or 127-mm (5-inch) flame test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, when flame tested as used in the equipment. The use of a flame-retardant coating applied to the inside of a polymeric enclosure is not acceptable unless the coating/material interface is found to be acceptable by separate investigation.

7.4.2 An impeller of polymeric material outside a motor shall not be located within 25.4 mm (1 inch) of an opening in the motor housing.

Exception No. 1: For all motor types except skeleton or open frame, an impeller is not prohibited from being within 25.4 mm of an opening in the motor housing when:

a) The material is classed as V-2, V-1, V-0, or 5V in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

b) The material complies with the requirements for enclosure flammability using a 19-mm (3/4-inch) flame, in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C;

c) No motor opening within 25.4 mm of the blade has a dimension more than 6.75 mm (17/64 inch) or an area more than 35.48 mm^2 (0.055 square inch), and no more than six such openings are provided;

d) 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;

e) The fan employs a thermally protected motor to drive the impeller and complies with the test requirements in Section 64, Impeller Ignition Test; or

f) The fan complies with the requirements for unattended areas as specified in Sections 178 and 179A.

Exception No. 2: For bobbin-wound skeleton motors employed in a product other than ceiling-insert, wall-insert fans, or rangehoods, an impeller is not prohibited from being within 25.4 mm of the motor windings when:

a) The impeller 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;

b) The coil is completely covered with insulation at least 0.8 mm (1/32 inch) thick; and

c) The space between the coil covering and bobbin does not exceed 0.8 mm total.

Exception No. 3: Bobbin-wound skeleton motors employed in a ceiling-insert fan, wall-insert fan, or rangehood, are not required to comply with this requirement.

7.4.3 A polymeric impeller for a fan intended to be installed in an area exposed to temperatures higher than 40°C (104°F), such as an attic fan or a fan intended for use in cooking areas, shall be molded from polymeric material having:

a) A heat deflection temperature under a minimum 455.07 kPa (66 psi) load of at least 75°C (167°F), determined as specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A; and

b) A relative mechanical temperature index without impact of at least 60°C (140°F) determined as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

7.4.4 Foamed thermoplastic shall be classed HF-2 or HF-1.

7.4.5 A thermoplastic damper shall be classed HB, V-2, V-1, V-0, or 5V.

7.4.6 A thermoplastic part that is not decorative and that does not serve as an enclosure shall be classed HB, V-2, V-1, V-0, or 5V.

8 Flame Spread and Smoke Developed Requirements for Non-Metallic Enclosures and Other Parts of Permanently Connected Equipment

8.1 A non-metallic enclosure or part that provides a barrier between a building cavity and internal parts of a fan that is intended to be permanently connected electrically, shall have a flame spread rating of zero in accordance with the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723.

Exception No. 1: A fan grille, duct adapter, or other part that is installed exterior to the enclosure or part described in 8.1 is not required to comply with the flame spread requirements.

Exception No. 2: A material having a flame-spread rating of 25 or less, as determined by the Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162, is an alternative.

Exception No. 3: This requirement does not apply to sound deadening material inside a fan enclosure that is rated HB or HF-2.

8.2 Compliance with the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043, is considered to meet the flame spread requirement of 8.1.

9 Accessibility of Moving Parts

9.1 General

9.1.1 The rotor of a motor, a pulley, a belt, a gear, an impeller, or other moving parts shall be enclosed, guarded, or installed at a sufficient height per 9.2, Portable fans and window fans, or 9.3, Stationary fans and permanently connected fans, as applicable, to reduce the risk of injury to persons.

Exception No. 1: This requirement does not apply to a part or portion of a part that is exposed to enable an appliance to perform its intended function.

Exception No. 2: This requirement does not apply to large commercial-industrial evaporative coolers intended for use in warehouses and similar spaces.

9.1.2 An impeller shall be constructed of a material and in such a manner to reduce the risk of its breakage or its release of parts that could cause a risk of injury to persons.

9.1.3 Polymeric guards which are used for protecting the impeller, and also function as an electrical enclosure, shall be subjected to the following tests as applicable:

a) For a guard of un-insulated live parts, the guard shall comply with the Resistance to Impact Test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, in the as-received condition. The impact used is to be 6.8 J (5 ft·lbf). Appliances intended to be used in cold environments, such as fans mounted in the crawl space or attic, and outdoor use products shall also be subjected to the Resistance to Impact Test of UL 746C in the cold condition.

b) For a guard of insulated live parts which have an insulation thickness of 0.71 mm (0.028 inch) or greater, the guard shall comply with Section 61, Impact Test on Guards, and Section 62, Static Force Test on Guards, in the as-received condition. Appliances intended to be used in cold environments, such as fans mounted in the crawl space or attic, and outdoor use products shall also be subjected to the Impact Test on Guards, 61.2, in the cold condition.

Exception: The cold condition Impact Test of UL 746C does not apply to portable fans marked for use in outdoor applications or, where impact testing is required, to ceiling insert fans/fan-light combinations.

9.1.4 An impeller shall be secured to the shaft, with consideration given to such factors as the size and weight of the impeller, motor power, mounted position, thrust direction, and the risk of injury to persons if breakage occurs. A reversible fan shall not rely solely on friction between the impeller and a nut turned onto a threaded shaft.

9.2 Portable fans and window fans

9.2.1 Other than as described in 9.2.2, a moving part that causes a risk of injury to persons shall be guarded or enclosed.

9.2.2 A moving part such as a rotating grille, rotating air deflector driven by an airstream, or an impeller is not required to be guarded when the moving part complies with all of the following applicable requirements:

a) When motor driven, the impeller:

1) Does not weigh more than 45 g (0.1 pound);

2) Is not more than 203.20 mm (8 inches) in diameter; and

3) Is not more than 3.2 mm (1/8 inch) thick and has no reinforcement beyond the nose cone.

b) When driven by an airstream, the moving part:

1) Does not weigh more than 454 g (1 pound);

2) Does not have a diameter that exceeds 508 mm (20 inches); and

3) Complies with Section 70, Drop Test, without breakage of the blades.

c) The moving part:

1) Does not rotate faster than 2000 revolutions per minute; and

2) Complies with the requirements specified in Section 56, Unguarded Impeller Tests, Section 61, Impact Test on Guards, and Section 70, Drop Test, without breakage of the blades.

d) The output power of the motor driving the part is not more than 35 watts (0.047 horsepower).

e) The "K" factor of the moving part determined as specified in 9.2.5 is less than 732.

f) A blade:

1) Employs a rounded leading edge with a diameter of at least 3.2 mm (1/8 inch); and

2) Is composed of material having:

i) A tensile strength of at least 6.895 MPa (1000 psi), in accordance with ASTM D638; and

ii) Elongation of not more than 206.85 MPa (30,000 psi), in accordance with ASTM D790.

g) An air deflector driven by the airstream has no leading edge and all exposed surfaces are smooth and well rounded.

Exception No. 1: An unguarded impeller is not required to comply with the requirements of 9.2.2(a)(1), (a)(2), (d), and (e) when the fan complies with 9.2.3.

Exception No. 2: An unguarded impeller is not required to comply with the requirements of 9.2.2(f)(2)(I), (f)(2)(ii), 9.2.2(b)(3), and 9.2.2(c)(2) if the impeller is molded of a component foam material rated a minimum HF-2.

9.2.3 An unguarded impeller that complies with Exception No. 1 to 9.2.2 shall produce an impact force of 175 N (39.34 pounds) or less.

9.2.4 Factors to be considered when judging whether a moving part or a portion of a part is likely to cause a risk of injury to persons shall include, but are not limited to:

a) The portion of the blade being contacted – trailing edge, leading edge, or periphery;

b) The blade material and angle, and type and sharpness of exposed edge; and

c) The energy available.

9.2.5 Conventional designs of impellers meet the requirement of being guarded when:

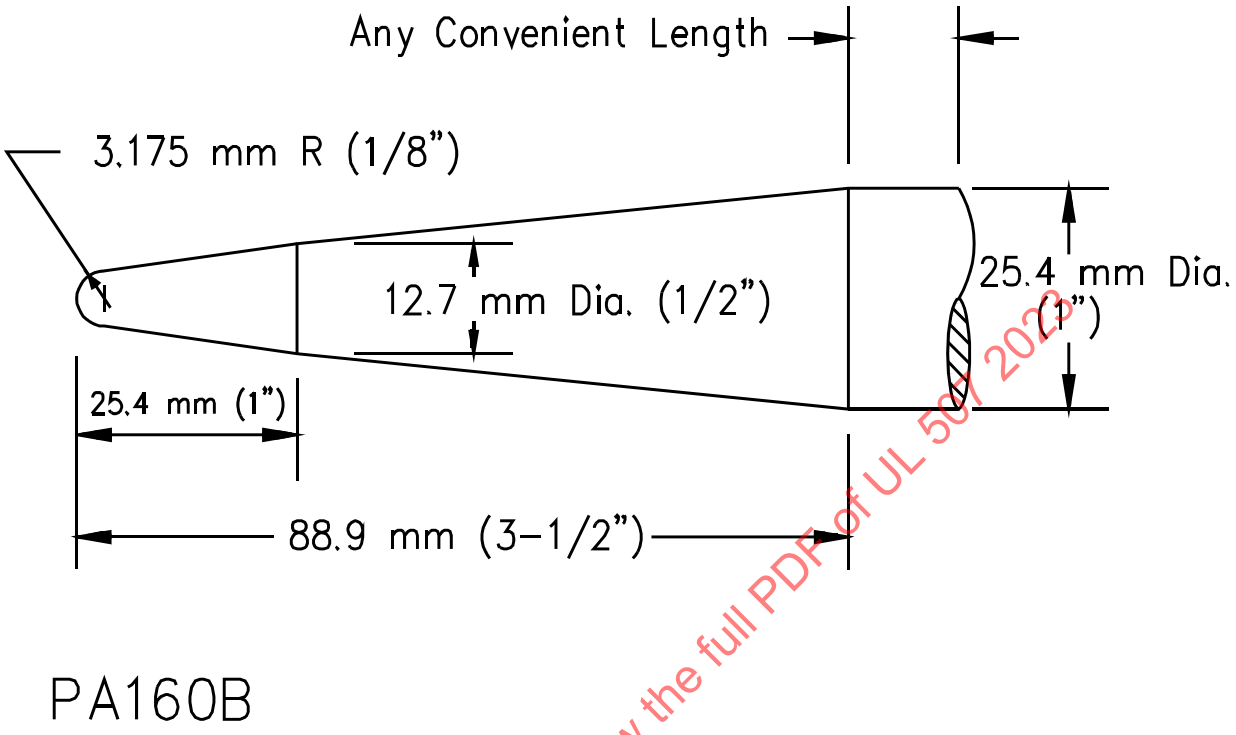
a) The relationship between mass (W) in kg, radius (r) in mm, and speed (N) in revolutions per minute is such that K in the following equation is less than 29264:

$$K = 6 \times 10^{-7} (Wr^2N^2)$$

b) The guarding is such that the probe illustrated in Figure 9.1 cannot touch the leading edge of the blade and hub when inserted as described in 9.2.6. For a reversible fan, both edges of the blade are considered leading edges. When K is greater than 29264, the probe shall not touch any part of the impeller.

Figure 9.1

Probe for impellers of portable appliances



9.2.6 The portion of an impeller that entails a risk of injury to persons shall be guarded so that the probe illustrated in Figure 9.1 does not touch the part when inserted with a force of 4.45 N (1 pound) for a maximum of 5 seconds through any opening in the guard.

9.2.7 During an examination to determine whether an appliance complies with the requirements specified in 9.2.6, the guards and impellers of desk and stand fans are not to be removed before examination.

9.2.8 When a part used to comply with the requirement in 9.2.6 is made of a polymeric material, a sample is to be exposed for 7 hours to air at 70°C (158°F). While in the oven, the part is to be assembled to the fan and the fan is to be in its intended operating position. After the sample has cooled to room temperature, the probe illustrated in Figure 9.1 is to be inserted through each opening in the guard. The probe shall not be able to touch any portion of an impeller that can cause a risk of injury to persons.

9.2.9 A guard employed to comply with the requirement in 9.2.6 shall be attached to the fan in any of the following ways:

a) Permanently;

b) By means requiring the use of a tool or tools for removal; or

c) By means not requiring the use of a tool or tools for removal provided that the securing means remain attached to the front or rear guard; and

1) Two separate motions, for example push and turn, are required to disengage the securing means; or

2) A force of 22.24 N (5 pounds) is required to disengage the securing means.

9.2.10 The removal force specified in 9.2.9(c)(2) is to be measured after conditioning the holding means by removing and replacing the guard ten times in the intended manner.

9.2.11 An enclosure, a frame, a guard, a handle, or other part of the fan that is exposed to contact during intended operation shall not be sufficiently sharp to constitute a risk of injury to persons.

9.2.12 Non-metallic impellers on portable fans and window fans shall comply with Section 63, Impeller Test for Portable Fans.

9.3 Stationary fans and permanently connected fans

9.3.1 In accordance with 9.1.1, the design and intended use of a stationary fan or of a fan intended to be permanently connected electrically is to be considered when evaluating an enclosure or guard.

9.3.2 The impeller of a stationary or permanently connected fan shall be constructed so that it cannot be contacted by the probe illustrated in Figure 9.2.

Exception No. 1: An impeller of an in-wall fan, or a plenum-mounted fan with the grille flush with the ceiling, is not required to be guarded when it is mounted at least 2.1 m (7 feet) above the floor and marked as specified in 81.4.

Exception No. 2: An impeller of a wall- or ceiling- insert fan shall comply with 9.3.4 – 9.3.5.

Exception No. 3: An impeller of a stationary or permanently connected nonresidential fan is not required to be guarded when it is mounted at least 2.1 m (7 feet) above the floor and marked as specified in 81.4 and either 80.1.10 or 141.1.

Exception No. 4: Residential attic fans and whole house fans shall comply with 9.3.6 and 9.3.7.

Exception No. 5: Ceiling-suspended fans shall comply with 90.2 and 92.1.

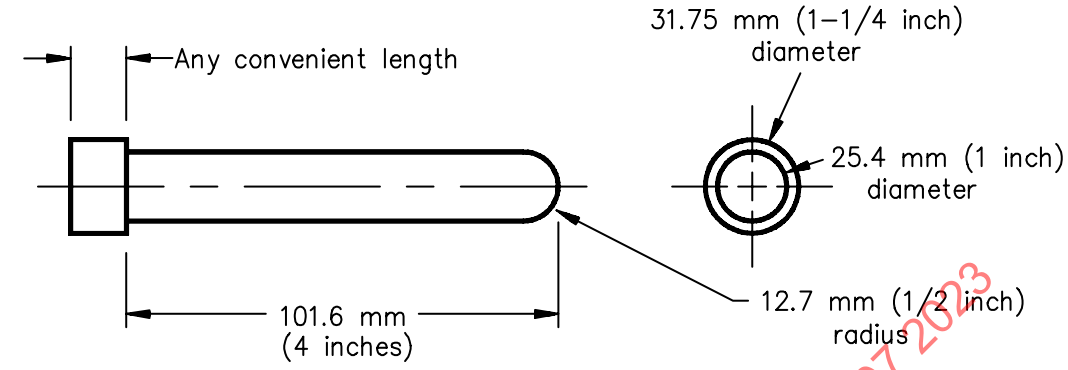
Exception No. 6: Fans for use in cooking areas shall comply with 113.3.1 – 113.3.3.

Exception No. 7: The discharge side of duct connected fans as described in 9.3.8 need not comply with this requirement.

Exception No. 8: The air inlet and/or discharge side of stationary or permanently connected fans need not comply with this requirement if the side(s) is intended by design to be attached to the duct work as specified in the manufacturer's instructions.

Figure 9.2

Probe for fan impellers and other moving parts of stationary fans and fans intended to be permanently connected electrically



9.3.3 A stationary or permanently connected fan shall be constructed so that any moving parts, other than the impeller, that cause a risk of injury to persons cannot be contacted by the probe illustrated in Figure 9.2.

9.3.4 The 25.4-mm (1-inch) diameter probe as illustrated in Figure 9.2, when inserted through an opening on the air-inlet side of a wall- or ceiling-insert fan, shall not contact a moving part that presents a risk of injury to a person.

Exception No. 1: This requirement does not apply to a wall- or ceiling-insert fan provided with a reusable metal filter or marked to be mounted at least 2.1 m (7 feet) above floor level. See 81.4.

Exception No. 2: This requirement does not apply to a wall- or ceiling-insert fan having an impeller diameter of 254 mm (10 inches) or less, when:

a) The wall- or ceiling-insert fan is marked as specified in 80.5.6; and

b) The installation instructions specified in 83.6 are provided.

Exception No. 3: This requirement does not apply to a wall- or ceiling-insert fan having an impeller 152.4 mm (6 inches) or less in diameter.

9.3.5 The unobstructed distance of an opening on the exhaust side of a wall-insert fan to a moving part capable of causing injury to persons shall be not less than 25.4 mm (1 inch) for an opening on the exhaust side of a wall- insert fan. When the unobstructed distance to such a part is 25.4 mm or more, the requirements of Table 9.1 apply.

Exception No. 1: A part less than 25.4 mm from the opening meets the intent of this requirement only when it cannot be contacted by the probe illustrated in Figure 9.2.

Exception No. 2: A wall-insert fan is not required to comply with these requirements when it is marked as specified in 81.4.

Table 9.1
Distance from opening to part capable of causing injury to persons

Diameter of opening		Minimum acceptable distance to moving part	
mm	(inches)	mm	(inches)
Less than 38.10	(1-1/2)	25.40	(1)
38.10 to 76.20	(1-1/2 to 3)	101.60	(4)
Greater than 76.20 but Less than 101.60	(3) (4)	152.40	(6)

9.3.6 A guard is not required on the side of an attic-mounted or roof-mounted fan intended to face an unoccupied space only when the installation instructions or a marking on the fan indicate that the fan is intended for use facing an unoccupied space only. See 80.6.1.

9.3.7 A guard is not required on the inlet side of a power attic or whole house ventilator when:

a) Louvers or a grill is provided in the box with the product; or

b) The installation instructions or marking on the attic-mounted or roof-mounted fan indicate that louvers or grilles are to be attached when the fan is installed as intended. See 80.6.2.

9.3.8 A guard is not required to be provided on the discharge side of a duct connected fan intended for connection to an exhaust duct.

10 Accessibility of Live Parts

10.1 General

10.1.1 To reduce the risk of unintentional contact that involves 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 comply with 10.2.1 – 10.3.1 and Table 10.1.

10.2 Application of probes

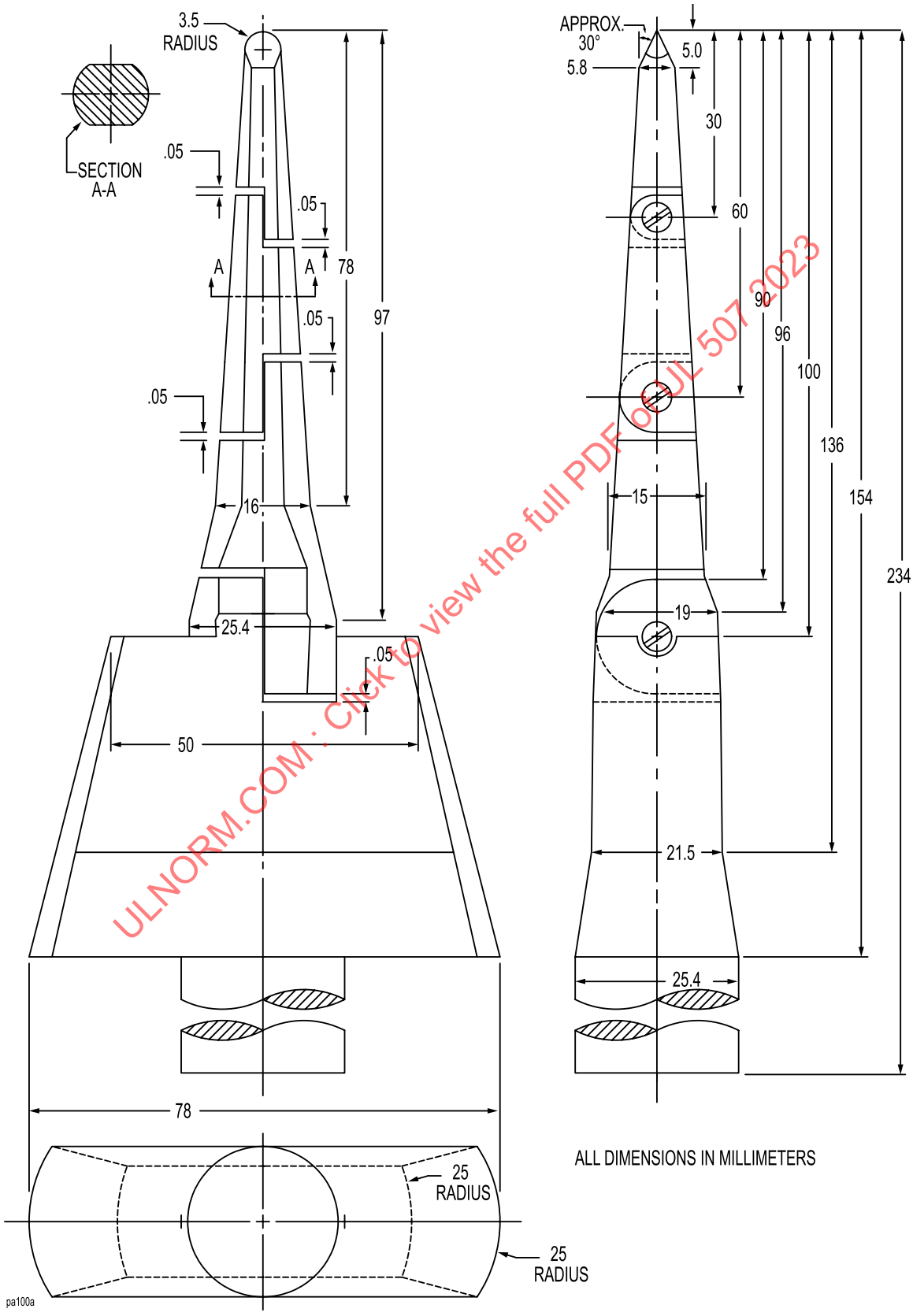
10.2.1 The probes referenced in Table 10.1 and illustrated in Figure 10.1 shall be applied to any depth that the opening permits and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to try to contact an uninsulated live part or film-coated wire. If necessary, the configuration shall be changed after insertion through the opening. Configuration refers to positioning of the jointed portions of the probes.

Table 10.1
Accessibility of live parts

Fan type	Figure reference of probe for judging accessibility	
	Uninsulated live parts other than film-coated wire	Film-coated wire
Ceiling-suspended, roof- mounted and attic fans	Figure 10.1 (Probe)	No requirement
Ceiling-insert, wall-insert, and rangehoods	Figure 10.1 (Probe)	Figure 10.1 (Probe)
All other fans	Figure 10.1 (Probe)	Figure 10.1 (Probe)

Figure 10.1

Articulate probe with web stop



10.2.2 The probes referenced in Table 10.1 and illustrated in Figure 10.1 shall be used as measuring instruments to judge the accessibility to uninsulated live parts and film-coated wire provided by openings and not as instruments to judge the strength of a material. Force is not to be applied to the probe when judging accessibility.

10.3 Removal of parts

10.3.1 During an examination to determine whether an appliance complies with the requirements specified in 10.1.1, 10.2.1, 10.2.2 and Table 10.1, a part intended to be removed by the user without the use of a tool, including the grille of a ceiling-insert or wall-insert fan and the filter of a rangehood, is to be removed before the examination.

10.3.2 With reference to 10.3.1, the filter or filters of an air-filtering appliance are 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.

10.3.3 With reference to the requirements specified in 10.1.1, 10.2.1, 10.2.2, and Table 10.1, insulated brush caps are not required to be additionally enclosed.

10.4 Disconnection means

10.4.1 A means of disconnection – such as a cord connector in conductors between the motor and the base of an oscillating fan – shall be such that live parts are not exposed under intended conditions.

11 Mechanical Assembly

11.1 An appliance shall be assembled so as not to increase the risk of injury to persons. Brush caps shall be tightly threaded or otherwise constructed to prevent loosening.

11.2 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 11.3.

Exception No. 1: A switch is not required to be prevented from turning when 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 subjected to such forces;

b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it (such as straight pull);

c) Spacings are not reduced below the minimum acceptable values when 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, is not required to be prevented from turning when rotation does not reduce spacings below the minimum acceptable values.

11.3 The means for preventing turning, as required by 11.2, 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.

11.4 A fan in which internal wiring or a part of the power-supply cord is enclosed in an adjustable column shall be constructed so that adjustment of the height of the column does not damage the wiring or the cord. When the wiring or cord is secured to two parts of the fan that can be rotated readily with respect to each other, means shall be provided to prevent a relative rotation of more than 360 degrees between such parts. See 11.5.

11.5 With reference to 11.4, it shall be assumed that two parts of a fan are able to be rotated readily with respect to each other when they are secured together by thumbscrews, wing nuts, or the like, or are otherwise readily adjustable by hand.

11.6 An appliance shall be completely assembled when it is shipped from the factory, except when the appliance is partially disassembled to facilitate packaging or installation, and the assembly of the appliance is readily accomplished without causing a risk of fire, electric shock, or injury to persons. When mismatching of components of an appliance shipped disassembled results in a risk of fire, electric shock, or injury to persons, the parts shall be marked as specified in 80.4.1. The installation instructions shall include statements as specified in 83.9.

11.7 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 with means that comply with requirements for field wiring in accordance with 14.3.5 or by plug and receptacle connection.

11.8 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.

11.9 An appliance that is shipped from the factory partially disassembled and is not marked in accordance with 80.4.1 shall be shipped in a single shipping container.

11.10 Uninsulated live parts of a thermostat provided with a welded stop shall not contact a dead metal part or parts of opposite polarity when breakage of the welded stop permits the thermostat to rotate.

12 Mounting Means

12.1 General

12.1.1 An appliance, other than as noted in 12.2.1 – 12.2.3, is to be mounted in accordance with the mounting requirements specified in the appropriate section of this Standard.

12.2 Cord-connected wall-mounted appliances

12.2.1 Mounting brackets and any necessary hardware required to install a cord-connected, wall surface-mounted appliance shall be provided with the appliance or shall be available from the appliance manufacturer.

Exception: Small parts commonly available for the mounting of the appliance are not required to be provided when the mounting instructions that refer to such parts are furnished in accordance with the requirements in Section 82, Important Safety Instructions, and Section 83, Installation Instructions.

12.2.2 With reference to 12.2.1, means shall be provided to reduce the likelihood that an appliance is dislodged from the wall. When the construction of the appliance or the mounting means permits the bottom of the appliance to swing or move, and such movement results in dislodging the appliance, means shall be provided to secure the bottom edge of the appliance to the wall.

12.2.3 An opening provided for hanging or mounting an appliance shall be located or guarded so that a nail, hook, or the like does not displace a part that creates a risk of fire, electric shock, or injury to persons and does not contact one of the following:

a) An uninsulated live part;

b) Film-coated wire;

c) Internal wiring; or

d) Moving parts.

13 Protection Against Corrosion

13.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or an equivalent means.

Exception No. 1: This requirement does not apply to a part in which corrosion does not result in a risk of fire, electric shock, or injury to persons.

Exception No. 2: This requirement does not apply to the surfaces of sheet-steel and cast-iron parts within an enclosure, when corrosion of the parts due to exposure of the metal to air and moisture is not appreciable – thickness of metal and temperature also being factors.

Exception No. 3: This requirement does not apply to bearings, laminations, or minor parts of iron or steel such as washers, screws, and the like.

14 Power Supply Connections – Permanently-Connected Appliances

14.1 General

14.1.1 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 is acceptable for the appliance in accordance with the National Electrical Code, ANSI/NFPA 70.

14.1.2 With reference to the requirement specified in 14.1.1, the following types of appliances shall be provided with means for permanent electrical connection to the power supply:

a) An attic fan;

b) An appliance intended for permanent attachment to a building structure;

c) A duct-connected appliance; or

d) A range hood.

Exception No. 1: A through-wall or in-glass fan not intended to be used in a cooking area is not required to be provided with a means for permanent electrical connection when it is provided with a power-supply cord that:

a) Is at least 0.46 m (18 inches) and not more than 3.05 m (10 feet) long;

b) Has three conductors, one being the equipment grounding conductor;

c) Is Type S, SJ, SJO, SJT, SJTO, SO, SP-3, SPT-3, ST, or STO;

d) Is permanently attached to the fan; and

e) Complies with the requirements in 15.1.3 and 15.2.1 – 15.2.5.

Exception No. 2: A portable fan with provision for temporary mounting, such as keyhole slots, is not required to be provided with means for permanent electrical connection when it is provided with a power-supply cord that is permanently attached to the fan and complies with the requirements of 15.1.3, 15.2.1 – 15.2.5, and Table 15.2.

Exception No. 3: A wall-mounted, ceiling-mounted, I-beam mounted, or suspension-bracket-mounted fan marked for commercial, industrial, or agricultural use is not required to have provision for permanent electrical connection when provided with a power-supply cord that:

a) Has three conductors;

b) Is Type SJ or heavier terminating in an acceptable grounding type attachment plug;

c) Has a length of 0.50 – 3.7 m (1.5 – 12 feet);

d) Is permanently attached to the fan;

e) Complies with the requirements of 15.1.3 and 15.2.1 – 15.2.5; and

f) Is marked in accordance with 80.1.10 or 141.1.

Exception No. 4: A down-draft fan is not required to be provided with a means for permanent electrical connection when it is provided with a power supply cord that:

a) Is at least 457.2 mm (18 inches) but not more than 762 mm (30 inches) long;

b) Has three conductors, one being the equipment grounding conductor;

c) Is Type S, SJ, SJO, SJT, SJTO, SO, ST, or STO;

d) Is permanently attached to the fan at a location intended to be below the surface of the cooking area; and

e) Complies with the requirements in 15.1.3 and 15.2.1 – 15.2.5.

Exception No. 5: A rangehood is not required to be provided with a means for permanent electrical connection when it complies with the requirements in 113.7, Cord-connected rangehoods; 113.8, Rangehood cord-connection kits; 114.6, Tests for cord-connected rangehoods; 114.7, Tests for rangehood cord-connection kits; Section 115, Rating for Cord-Connected Rangehoods; Section 117, Installation Instructions for Rangehoods and Rangehood Cord-Connection Kits, and 116.3 – 116.5.

Exception No. 6: An in-line duct fan is not required to be provided with a means for permanent electrical connection when it is provided with the marking defined in item (f) and it is provided with a supply cord that:

a) Is not longer than 1.82 m (6 feet) measured from the point at which the cord emerges from the unit to the face of the attachment plug;

b) Is Type SJ or equivalent;

c) Is permanently attached to the fan;

d) Has three conductors, one being the equipment grounding conductor;

e) Complies with the requirements of 15.1.3, 15.1.5, 15.1.6, and 15.2.1 – 15.2.5; and

f) Is marked in accordance with 80.1.11.

Exception No. 7: An attic fan is not required to be provided with a means for permanent electrical connection when it is provided with a power-supply cord that:

a) Has three conductors, one being the equipment grounding conductor;

b) Is type S, SJ, SJO, SJT, SJTO, SO, ST, or STO;

c) Has a length of 0.50 – 1.82 m (1.5 – 6 feet);

d) Is permanently attached to the fan;

e) Complies with the requirements of 15.1.3 and 15.2.1 – 15.2.5;

f) Is marked or it is noted in the installation instructions "CAUTION: Do not use with extension cord." and

g) Does not contact the fan blade by one of the following methods:

1) Guarding of the moving blade to reduce likelihood of cord contact; or

2) Location of cord exit and length of cord is such that likelihood of cord contact with moving blade is minimized; or

3) Instructions are provided as well as cord tag marking to instruct the installer to route cord away from fan blade.

14.1.3 Power supply terminal or leads identified for connection to Class 2 wiring shall comply with Class 2 circuit requirements, 31.3.

14.2 Knockouts and openings

14.2.1 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, shall be securely attached and removable without deformation that would impair the intended performance of the enclosure. The thickness of the knockout shall be in accordance with the thicknesses specified in Table 7.1.

14.2.2 There shall be a flat surface surrounding a knockout or opening 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 or opening. The flat area shall have a minimum diameter in accordance with Table 14.1.

14.2.3 A knockout or opening shall be surrounded on both the inside and outside surfaces by a flat surface to permit proper installation of a locknut. The flat surface shall extend in all directions beyond the edge of the knockout for a distance not less than that specified in Table 14.1.

Exception: A knockout construction complying with the polymeric enclosure tests, Section 8.6 of the Standard for Enclosure of Electrical Equipment, Non-Environmental Considerations, UL 50, and Limited Short-Circuit Test, Section 43, is not required to comply.

Table 14.1
Dimensions associated with openings for conduit

Trade size of conduit		Unthreaded openings			
		Nominal knockout diameter[a]		Minimum diameter of flat surface at knockout	
mm	(inches)	mm	(inches)	mm	(inches)
12.70	(1/2)	22.22	(0.875)	29.26	(1.152)
19.05	(3/4)	27.78	(1.109)	36.83	(1.450)
25.40	(1)	34.53	(1.375)	45.82	(1.804)

[a] A plus tolerance of 0.79 mm (0.031 inch) and a minus tolerance of 0.38 mm (0.015 inch) applies to the knockout opening diameter. Knockout diameters are to be measured other than at points where a tab remains after removal of the knockout.

14.3 Field-wiring compartments

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

Exception: This requirement does not apply to a field-wiring compartment in a hood-type fan that, in accordance with the manufacturer's instructions, is installed behind a hinged or sliding cabinet door or the like.

14.3.2 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, if no instructions are provided.

14.3.3 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 14.2.

Table 14.2
Minimum usable volume of terminal compartment

Size of conductors		Volume for each conductor that originates outside the compartment and terminates or is spliced within the compartment, and each conductor that passes through the compartment without splice or termination, including a grounding conductor.	
AWG	(mm^2)	cm^3	(cubic inches)
18	(0.8)	24.6	(1.50)
16	(1.3)	28.7	(1.75)
14	(2.1)	32.77	(2.00)
12	(3.3)	36.87	(2.25)
10	(5.3)	40.97	(2.50)
8	(8.4)	49.16	(3.00)
6	(13.3)	81.94	(5.00)

14.3.4 A motor containing an integral wiring compartment shall comply with the requirements of the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

14.3.5 An electrical component shall not be mounted on a part, such as the cover of a wiring-terminal compartment, that is removed to permit field-wiring connections or inspections.

Exception No. 1: A ceiling-insert, wall-insert, or hood-type fan, having a blade diameter of 304.8 mm (12 inches) or less, in which the power-supply-circuit wires are intended to be connected to an attachment-plug receptacle into which the leads to the motor or other electrical component are plugged are not prohibited from having the receptacles with integral leads mounted on the cover.

Exception No. 2: Components such as switches, thermostats, or the like shall not be mounted on a wiring compartment cover unless:

a) The component is mounted so as to be prevented from turning;

b) The leads are of sufficient length to permit examination of splice connections without placing stress on the terminals;

c) The length of the leads prevents contact with a moving part or a part that operates at a temperature higher than the rating of the wiring;

d) The component wiring terminals are not field-wired;

e) Factory-installed pigtail leads can withstand a pull of 22.24 N (5 pounds) for 1 minute;

f) Strain relief is provided to prevent stress from being placed on the terminals;

g) The minimum size of the pigtail leads is 18 AWG (0.82 mm^2); and

h) There are no exposed wiring terminals on the back of the switch, thermostat, and the like.

14.3.6 A field-wiring compartment intended for connection of a supply raceway and mounted integrally with the appliance shall be attached so as to be prevented from turning with respect to the appliance.

14.3.7 When the constructional features of an appliance permit field-wiring connections to be made in the motor terminal compartment, the compartment shall comply with the applicable requirements for electric motors.

14.3.8 An opening in a roof-mounted appliance for a power-supply or external control-circuit connection shall be threaded unless:

a) It is located entirely below the lowest uninsulated live part within the enclosure; or

b) Its location prevents drainage into the enclosure.

The metal at a threaded opening for a wiring system shall be not less than 6.35 mm (1/4 inch) thick, and an end-stop shall be provided, unless the thread is tapered. See 166.6.8.

14.4 Wiring terminals and leads

14.4.1 A field-wiring terminal is a terminal to which a wire is connected in the field, unless the wire and a means of making the connection – a pressure terminal connector, soldered loop, crimped eyelet, or the like – factory-assembled to the wire, are provided as part of the appliance.

14.4.2 A fan intended to be permanently connected electrically and rated 12 Amps or less shall be provided with wiring terminals, including an equipment grounding terminal, for the connection of conductors having an ampacity acceptable for the appliance. Otherwise, the fan shall be provided with

leads not smaller than 18 AWG (0.82 mm^2). When the fan rating exceeds 12 Amps, terminals shall be suitable for 125 percent of the current rating of the fan.

Exception: Leads shall not be smaller than 18 AWG unless they are taped together and connected so that the individual conductors have a total cross-sectional area of at least 0.82 mm^2.

14.4.3 A wiring terminal shall be provided with an acceptable pressure terminal connector securely fastened in place – for example, firmly bolted or held by a screw.

Exception: A wire-binding screw is not prohibited from being employed at a wiring terminal intended for connection of a 8 AWG (8.4 mm^2) or smaller conductor when upturned lugs or the equivalent are provided to hold the wire in position.

14.4.4 A wiring terminal shall be prevented from turning or shifting in position.

14.4.5 A wire-binding screw at a field-wiring terminal shall not be smaller than No. 10 (4.8 mm diameter).

Exception No. 1: This requirement does not apply to a No. 8 screw (4.2 mm diameter) being used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) or smaller conductor.

Exception No. 2: This requirement does not apply to a No. 6 screw (3.5 mm diameter) being used at terminal intended only for connection of a 16 or 18 AWG (1.3 mm^2 or 0.82 mm^2) conductor.

14.4.6 It should be noted that 14 AWG (2.1 mm^2) is the smallest conductor that shall be used for branch-circuit wiring, and thus is the smallest conductor that shall be anticipated at a terminal for connection of a power-supply wire.

14.4.7 A terminal plate tapped for a wire-binding screw shall be of metal not less than 1.27 mm (0.050 inch) thick. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

Exception: A plate not less than 0.76 mm (0.030 inch) thick meets the intent of this requirement when the tapped threads have equivalent strength in accordance with the Standard for Terminal Blocks, UL 1059.

14.4.8 Upturned lugs, a cupped washer, or the equivalent shall be capable of retaining a conductor of the size specified in 14.4.2 under the head of a screw or washer.

14.4.9 The free length of a lead inside an outlet box or wiring compartment shall be 152.4 mm (6 inches) or more when the lead is intended for field connection to an external circuit.

Exception: A lead shall not be less than 152.4 mm long unless it is evident that use of a longer lead results in a risk of fire, electric shock, or injury to persons.

14.4.10 A screw used to secure an equipment grounding lead to an enclosure shall engage at least two full threads in the metal, which is not prohibited from being extruded to provide the threads.

14.5 Identification

14.5.1 A permanently connected appliance rated 125 volts or 125/250 volts (3-wire) or less, and employing a lamp- or element-holder of the Edison screw-shell type, or a single-pole switch or overcurrent-protective device other than an automatic control without a marked "off" position shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The terminal or lead so identified shall be the one that is electrically connected to the screw shell of a lamp- or

element-holder but to which shall not be connected a single-pole switch or single-pole overcurrent-protective device, other than an automatic control without a marked "off" position.

14.5.2 With reference to 14.5.1, if leads from the motor or other component terminate in an attachment plug intended for insertion in a receptacle that is:

a) Provided as part of the appliance; and

b) Intended for connection of the branch-circuit power-supply conductors.

The plug and receptacle shall be polarized if a single-pole switch or an Edison-base lampholder is connected to the plug.

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

14.5.4 The surface of a lead intended for the connection of a grounded power-supply conductor shall have a white or gray color and shall be readily distinguishable from the other leads.

14.5.5 The surface of a lead intended for 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.

14.5.6 A terminal intended for the connection of an equipment-grounding conductor shall be identified by:

a) Use of a wire-binding screw with a green-colored head that is slotted or hexagonal, or both;

b) Use of a threaded stud with a green-colored hexagonal nut;

c) Use of a green-colored pressure-terminal connector;

d) Being marked "G," "GR," "GND," "Ground," "Grounding," the grounding symbol, ⏚, or the like; or

e) A marking on a wiring diagram provided on the appliance.

15 Power Supply Connections – Cord-Connected Appliances

15.1 Cords and plugs

15.1.1 A portable appliance shall be provided with a flexible cord in accordance with Table 15.1 and an attachment plug for connection to the power-supply circuit. The length of cord external to the appliance shall be measured from the face of the attachment plug to the point of attachment or entry into the enclosure.

Exception: A power supply cord provided on an air filtering appliance also evaluated to the Standard for Vacuum Cleaners, Blower Cleaners and Household Floor Finishing Machines, UL 1017, may exceed the maximum length specified in Table 15.1 provided it meets all other requirements in both UL 507 and UL 1017.

15.1.2 A product as described in Table 15.1, rows 1 and 2, but intended for commercial or industrial use, shall employ a cord as described Table 15.1, row 3, and be marked in accordance with 80.1.10.

Table 15.1
Cords for appliances

Appliance	Type of cord[a]	Length, m (ft)
1. Fan not intended to rest directly on floor when in use. For example, a bracket fan, window only fan, or portable wall fan mounted with keyhole slots.	SPT- 2-R, HPN-R, SVT-R, SJT-R. The cord shall comply with the Standard for Flexible Cords and Cables, UL 62	1.5 – 3 (5 – 10)
2. Fan that rests directly on floor when in use, except for the type of fan indicated in item 3, 6, or 7. For example, a desk fan or box fan.	SPT-2-R, HPN-R, SVT-R, SJT-R. The cord shall comply with the Standard for Flexible Cords and Cables, UL 62	1.5 – 3 (5 – 10)
3. Fan intended for commercial or industrial use, except for the type of fan indicated in item 7. For example, a commercial air filtering appliance.	SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400.4 of the National Electrical Code, ANSI/NFPA 70	1.5 – 7.6 (5 – 25)
4. Portable or window-type evaporative household cooler and household air filtering appliances.	SP-2, SPT-2, or of a type equally serviceable for the application[a]	1.5 – 3 (5 – 10)
5. Commercial, industrial, or agricultural fan mounted as specified in Exception No. 3 of 14.1.2.	SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400.4 of the National Electrical Code, ANSI/NFPA 70	0.5 – 3.7 (1.5 – 12)
6. Portable fan employing a general use convenience receptacle, or evaporative cooler with or without a general use convenience receptacle.	SJ, SJE, SJO, SJT, SJTO or equivalent	0.5 – 7.6 (1.5 – 25)
7. Dryer type fan and commercial display blower except as noted in Item 8.	SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400.4 of the National Electrical Code, ANSI/NFPA 70	1.5 – 30.5 (5 – 100)
8. Dryer type fan and commercial display blower provided with a "stubby cord" for use with an extension cord.	SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400.4 of the National Electrical Code, ANSI/NFPA 70	0.203 – 0.457 (0.67 – 1.5)

[a] An SVT cord type is considered equally serviceable to SPT-2.

15.1.3 The flexible cord shall be rated for use at a voltage not less than the rated voltage of the appliance, and shall have an ampacity not less than the current rating of the appliance.

15.1.4 The flexible cord for products as described in rows 1 and 2 of Table 15.1 shall be attached permanently to the appliance or be in the form of a separate cord set with acceptable means for permanent connection to the appliance.

15.1.4.1 An appliance intended for use with a detachable cord set shall not be provided with terminal pins that accommodate a standard flatiron or appliance plug.

15.1.5 The voltage rating of the attachment plug shall not be less than that of the appliance. When an appliance can be adapted for use on two or more different values of voltage by field alteration of internal connections, the attachment plug shall be rated for the voltage for which the appliance is connected when shipped from the factory. See 80.2.2.

15.1.6 The current rating of the attachment plug for an appliance rated 12 amperes or less shall not be less than the current rating of the appliance. For an appliance rated more than 12 amperes, the current rating of the attachment plugs shall not be less than 125 percent of the current rating of the appliance.

15.1.7 The attachment plug of the power supply cord of an appliance provided with a 15- or 20-ampere general-use convenience receptacle shall be of the 3-wire grounding type. The attachment plug of the

power supply cord of all other appliances not required to be grounded shall be polarized or of the grounding type.

15.1.8 When a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connections shall comply with Figure 15.1, and the polarity identification of the flexible cord shall comply with Table 15.2.

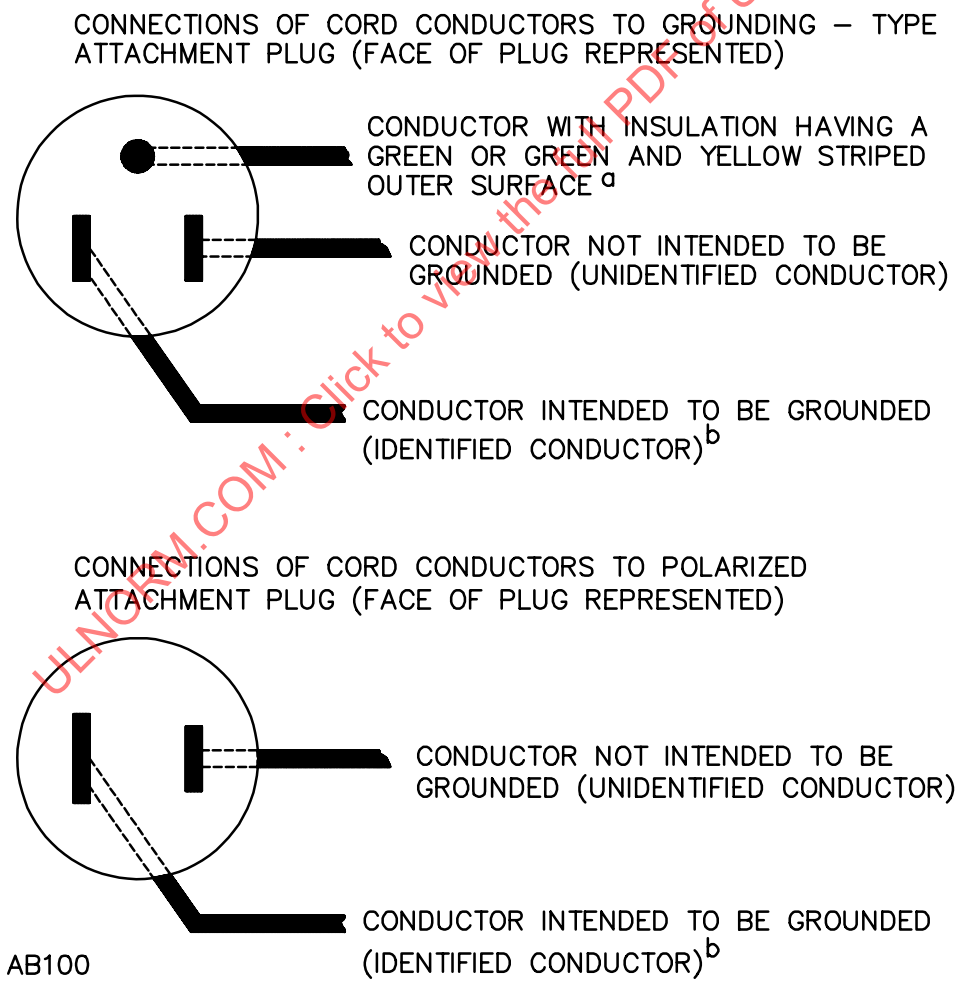
15.1.9 The conductor of the power supply cord that is intended to be grounded shall have the following items connected to it:

a) The screw shell of an Edison-base lampholder; and

b) The terminal or lead receptacle intended to be grounded. Table 15.2 identifies the supply cord conductor intended to be grounded.

Figure 15.1

Connection to attachment plug



[a] The blade to which the green conductor is connected may have a U-shaped or circular cross section.

[b] Signifies a conductor identified in accordance with Table 15.2.

Table 15.2
Polarity identification of flexible cords

Method of polarity identification	Acceptable combinations	
	Wire intended to be grounded[d]	All other wires
Colored braid	Solid white or gray	Solid color other than white or gray
Tracer in braid	Solid white or gray braid with no tracer in braid[b]	Solid white or gray braid with a colored tracer in braid[b]
	Colored tracer in braid of a color other than white or gray	No tracer in braid of solid color other than white or gray
Colored insulation[c]	Solid white or gray[a]	Solid color other than white or gray
	Light blue[d]	Solid color other than light blue, white, or gray[d]
Colored separator[e]	White or gray	Color other than white or gray
Tinned conductors[f]	Tin or other white metal on all strands of the conductor	No tin or other white metal on the strands of the conductor
Surface marking[e]	One or more stripes, ridges, or grooves, or a combination of these on the exterior surface of the cord	

[a] A conductor having insulation finished to show a green color with or without one or more straight or helical unbroken yellow stripes or having a green braid with or without one or more yellow tracers is to be used only as an equipment grounding conductor. See Figure 15.1 for the connection of conductors to attachment plugs.

[b] Only for Types C and PD cords.

[c] Only for a cord having no braid on any individual conductor.

[d] Only for a cord having a jacket that is not integral with the circuit conductor insulation.

[e] Only for Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2 cords.

[f] Only for Types SPT-1 and SPT-2 cords.

15.1.10 A flexible power supply cord shall not be smaller than 18 AWG (0.82 mm^2).

15.1.11 The ampacity of a flexible power supply cord shall be as specified in Table 400.5(A) of the National Electrical Code, ANSI/NFPA 70. For reference purposes, an abbreviated table showing the ampacities for flexible cord with two current carrying copper conductors is shown in Table 15.3.

Table 15.3
Ampacities for flexible cords

Conductor size		Ampacity
AWG	(mm^2)	(Amperes)
18	(0.82)	10
17	(1.04)	12
16	(1.31)	13
14	(2.08)	18
12	(3.31)	25

15.2 Strain relief

15.2.1 Strain relief shall be provided so that the mechanical stress on the flexible cord is not transmitted to terminals, splices, or internal wiring. See 54.1.

15.2.2 A metal strain-relief clamp or metal band is acceptable without supplementary protection on a Type SJ, SJO, SJT, SJTO, S, SO, ST, STO, SV, or SVO cord.

15.2.3 A metal strain-relief clamp or metal band shall not be used on Type SP-2 or lighter rubber-insulated cord or on Type SPT-1, SPT-2, SVT, or SVTO cord unless such a cord is protected by varnished cloth tubing or the equivalent under the clamp, and the construction complies with the requirements specified in 54.5.

15.2.4 Means shall be provided to prevent the supply cord or lead from being pushed into the enclosure of an appliance through the cord-entry hole when such displacement results in:

a) Subjecting the supply cord or lead to mechanical damage;

b) Exposing the supply cord or lead to a temperature higher than that for which it is rated;

c) Reducing spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damaging internal connections or components.

To determine compliance, the supply cord or lead shall be tested in accordance with Section 57, Push Back Relief Test.

15.2.5 When a knot in a flexible cord serves as the strain relief, the surfaces that the knot touches shall be free from projections, sharp edges, burrs, fins, or similar edges that damage the conductors.

Exception: A knot shall not be employed to provide strain relief for cord-connected rangehoods.

15.3 Bushings

15.3.1 A bushing or the equivalent shall be provided at a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case. The bushing shall be substantial, secured in place, and shall have a smooth, well-rounded surface against which the cord may bear. An insulating bushing shall be provided when:

a) The cord is Type SP-1, SPT-1, SP-2, or SPT-2, or other type lighter than Type SV;

b) The wall or barrier is of metal; and

c) The construction is such that the cord is subjected to stress or motion.

Exception: For a cord hole in wood, porcelain, phenolic composition, or other nonconductive material, a smoothly rounded surface is considered to be the equivalent of a bushing.

15.3.2 Ceramic materials and some molded compositions are acceptable for insulating bushings.

15.3.3 Vulcanized fiber is not prohibited from being employed if the bushing is not less than 1.2 mm (3/64 inch) thick, and if formed and secured in place so that it is not damaged by conditions of ordinary moisture.

15.3.4 A separate soft-rubber, neoprene, or polyvinyl chloride bushing is not prohibited from being employed in a fan, or in the frame of a motor, or in the enclosure of a capacitor attached to a motor of an evaporative cooler, or a room-type filter unit if the bushing is:

a) Not less than 1.2 mm (3/64 inch) thick; and

b) Located so that it is not exposed to oil, grease, oily vapor, or other substances that deteriorate the compound employed.

15.3.5 A bushing of a material mentioned in 15.3.4 shall not be employed in an appliance unless used in conjunction with a type of cord for which an insulating bushing is not required.

15.3.6 When a bushing of a material mentioned in 15.3.4 is used, the hole in which the bushing is mounted shall be smooth and free from sharp edges.

15.3.7 A bushing of the same material as, and molded integrally with, the supply cord is acceptable on a Type SP-1 or heavier cord, only when the built-up section is not less than 1.6 mm (1/16 inch) thick at the point where the cord passes through the enclosure.

15.3.8 An insulated metal grommet is acceptable in place of an insulating bushing if the insulating material is not less than 0.8 mm (1/32 inch) thick and completely fills the space between the grommet and the metal in which it is mounted.

16 Supply Cord Overcurrent Protection

16.1 An appliance described by rows 1 and 2 of Table 15.1 shall be provided with integral overcurrent protection.

Exception: A product employing a direct plug-in Class 2 power unit which complies with the applicable requirements in the Standard for Class 2 Power Units, UL 1310, is not required to be provided with integral overcurrent protection.

16.2 A fuse provided for overcurrent protection shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14, and Section 24.

16.3 A supplementary protector provided for overcurrent protection shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077. The supplementary overcurrent protection device shall comply with the Overload Test in UL 1077, tested at 1.5 or 6 times the AC full load current rating. The overload test current and power factor shall be determined based upon the motor locked rotor current and power factor.

16.4 The overcurrent protection shall be either an integral part of the attachment plug, or of a through-cord design (in-line fuseholder) located so that there is no more than 152 mm (6 inches) between the face of the attachment plug and the side of the fuseholder furthest from the attachment plug.

16.5 The rating of the overcurrent protection shall be a maximum of 5A.

16.6 The overcurrent protection shall be connected to the ungrounded conductor of the power supply.

17 Special Protection Devices

17.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943. The following statement, or equivalent, shall be included as a marking near the GFCI, or as an instruction in the manual: “Press the TEST button (then RESET button) every month to assure proper operation.”

17.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B.

Note – An ALCI is not considered an acceptable substitute for a GFCI when the National Electrical Code, ANSI/NFPA 70, requires a GFCI.

17.3 Equipment ground-fault protective devices shall comply with the Standard for Ground-Fault Sensing and Relaying Equipment, UL 1053, and the applicable requirements of the Standard for Ground-Fault Circuit-Interrupters, UL 943.

17.4 An arc-fault circuit-interrupter (AFCI) or leakage-current detector-interrupter (LCDI) provided as part of a cord-connected appliance shall comply with the Standard for Arc-Fault Circuit-Interrupters, UL 1699, and the requirements of 17.5 – 17.7.

17.5 The AFCI or LCDI shall be installed as an integral part of the attachment plug or located in the supply cord within 102 mm (4 inches) of the attachment plug.

17.6 Arc fault detection testing shall include the following, as applicable:

a) Carbonized path arc clearing time test;

b) Point contact arc test;

c) Unwanted tripping test – Load Condition I;

d) Unwanted tripping test – Load Condition II – Condition C and D;

e) Unwanted tripping test – Load Condition III – Condition A; and

f) Masking.

Exception: The carbonized path arc clearing time test is not applicable for LCDIs that are provided with shielded power-supply cords.

17.7 An AFCI or LCDI provided as part of an appliance intended for outdoor use shall comply with the applicable requirements of Sections 165 – 167.

18 Live Parts

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

18.2 Ordinary iron or steel that is provided with a corrosion-resistant coating is not prohibited from being used as a current-carrying part in accordance with the following:

a) When acceptable in accordance with 6.1.1; or

b) Within a motor or associated governor, but the use of ordinary iron or steel for current-carrying parts elsewhere in the appliance is not acceptable.

18.3 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 is prevented from turning or shifting in position when spacings are reduced below the minimum values specified in Spacings, Section 30.

18.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part. A toothed lock washer with spring take-up, applied as intended, is acceptable.

19 Internal Wiring – Electrical Connections

19.1 The internal wiring and connections between parts of an appliance shall be protected or enclosed in accordance with 19.2.

Exception: A length of flexible cord is not prohibited from being employed for external interconnection only when flexibility is essential.

19.2 Internal wiring, consisting of individual insulated conductors either separate or in a harness, and electrical connections are considered to be acceptably protected when either of the following apply:

a) When judged as though it were film-coated wire, the wiring complies with 10.1.1; or

b) Even though it could be touched by the probe specified in 10.1.1, the wiring is secured so that it cannot be grasped or hooked in such manner that it or related electrical connections are subjected to undue stress.

A grill, louver, or the like, regardless of how secured in place, is not to be removed when the exposure of internal wiring is being judged, but a filter, or other device provided in lieu of a filter, on a fan intended for use in a cooking area is to be removed during the examination. The location in which the appliance is intended to be mounted when in service is also to be taken into consideration in determining compliance with this requirement – that is, a relatively greater degree of exposure of internal wiring is acceptable if the appliance is likely to be installed in a location, such as an attic, where it will be remote from persons.

19.3 The internal wiring and connections of an appliance shall consist of components of a type or types that are acceptable for the particular application, when considered with respect to:

a) The temperature and voltage to which they are likely to be subjected;

b) Exposure to oil, grease, or moisture; and

c) To other conditions of service to which they are likely to be subjected.

19.4 Wiring shall be protected from sharp edges including male screw threads, burrs, moving parts, and other agents that might cause abrasion of the insulation on conductors.

19.5 A flexible cord used for external interconnection as mentioned in 19.1 shall be provided with bushings and strain relief that comply with Section 54, Strain Relief Test.

19.6 Insulated conductors that pass through an opening in a sheet-metal wall that is not more than 1.07 mm (0.042 inch) thick shall be:

a) Securely held away from the edges of the opening;

b) Protected by a bushing, metal grommet, eyelet, or the equivalent; or

c) Protected by rolling the edge of the metal opening at least 120 degrees.

19.7 A non-metallic bushing as mentioned in 19.6(b) shall:

a) Be securely held in place; and

b) Have a minimum wall thickness of 1.2 mm (3/64 inch).

19.8 The edges of an opening in sheet metal more than 1.07 mm (0.042 inch) thick shall be treated to prevent abrasion of the insulation by removal of burrs, fins, and sharp edges.

19.9 Insulated wires are not prohibited from being bunched and passed through a single opening in a metal wall within the enclosure.

19.10 All splices and connections shall be mechanically secure and shall maintain electrical contact.

19.11 A soldered connection shall be made mechanically secure before being soldered when breaking or loosening of the connection causes a risk of fire, electric shock, or injury to persons.

19.12 With reference to 19.11, a lead is considered to be mechanically secure when one or more of the following are provided:

a) At least one full wrap around a terminal;

b) The lead is passed through an eyelet or opening;

c) The lead is twisted together with another conductor.

19.13 A splice shall be provided with adequate insulation equivalent to that on the wires involved when permanence of spacing between the splice and other metal parts is not maintained.

19.14 Insulation consisting of two layers of friction tape, two layers of thermoplastic tape, or of one layer of friction tape wrapped over one layer of rubber tape, is acceptable on a splice when the voltage involved is less than 250 volts. In determining if splice insulation consisting of coated-fabric, thermoplastic, or other tubing is acceptable, consideration is to be given to such factors as dielectric properties, heat-resistant and moisture-resistant characteristics, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable.

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

19.16 Wiring that connects the motor and the base of an oscillating fan shall:

a) Have conductors with individual strands not larger than 34 AWG (0.02 mm^2);

b) Have rubber or other insulation not less than 0.4 mm (1/64 inch) thick on each conductor; and

c) Not be of such length and location that results in damage by intended operation.

19.17 Internal connections from the motor or light in a wall-insert fan, a ceiling-insert fan, or a ceiling-insert fan/light combination to the fan shall be made by a plug and receptacle connection.

19.18 The cord or wiring employed for receptacle/motor or light interconnection or other interconnection purposes within a wall-insert fan, ceiling insert fan, or a ceiling-insert fan/light combination shall comply with the strain relief test requirements for Interconnecting Cords and Leads, Section 55.

20 Insulating Material

20.1 Insulating material employed in an appliance is to be judged with respect to its acceptability for the particular application. Materials such as mica and certain refractory materials are acceptable for use as the sole support of live parts. Other materials not acceptable for general use, such as magnesium oxide, may be acceptable if used in conjunction with other insulating materials, or if so located and protected that the risk of mechanical damage and the absorption of moisture are reduced. When it is necessary to investigate a material to determine its acceptability, consideration is to be given to its mechanical strength,

insulation resistance, heat-resistant qualities, the degree to which it is enclosed or protected, and any other features having a bearing on the risk of fire, electric shock, or injury to persons involved in conjunction with conditions of service. All these factors are to be considered with respect to thermal aging. Polymeric materials shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

20.2 Vulcanized fiber is not prohibited from being used for an insulating bushing, washer, separator, or barrier and shall not be used as support for uninsulated live parts.

20.3 A molded part shall have mechanical strength and rigidity to withstand the stresses of intended service. Brush caps shall be secured or located so as to be protected from mechanical damage that occurs during intended use.

21 Receptacles

21.1 A 15- or 20-ampere attachment-plug receptacle intended for general use as a convenience receptacle in a fan shall be of the grounding type, and shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

21.2 A fan shall not be provided with more than two single or one duplex convenience receptacles.

21.3 A general use convenience receptacle provided on a fan shall be wired so that it provides the same polarized supply as the attachment plug of the fan.

21.4 The minimum power supply cord size for a portable fan shall be in accordance with Table 21.1.

Table 21.1
Minimum power supply cord size for portable fans employing a general use convenience receptacle

Rating of fan (Amperes)	Minimum power supply cord (AWG)
12 or less	14
12 – 16	12

21.5 The power supply cord of a portable fan employing a general use convenience receptacle shall not employ a through cord switch.

21.6 A detachable power supply cord shall not be used with a portable fan employing a general use convenience receptacle.

21.7 A general use convenience receptacle shall not be provided on any fan intended to be installed in a cooking area.

Exception: This requirement does not apply to a ventilating-hood-fan shelf. See Section 128, Construction.

21.8 Internal wiring for a general use convenience receptacle shall be in accordance with Table 21.2.

Table 21.2
Internal wiring for fans employing a general use convenience receptacle

Ampacity of receptacle (Amperes)	Internal wiring (AWG)
15	14
20	12

21.9 When the face of a general use convenience receptacle is less than 15.9 mm (5/8 inch) wide or less than 22.2 mm (7/8 inch) long, the face of the receptacle shall project not more than 4.8 mm (3/16 inch) from the part of the mounting surface that is within a rectangle 22.2 mm (7/8 inch) long and 15.9 mm (5/8 inch) wide symmetrically located about the receptacle contacts; and when the mounting surface is conductive, the face of the receptacle shall project not less than 2.4 mm (3/32 inch) from that part of the mounting surface.

21.10 The area surrounding a general use convenience receptacle shall be free of any projection that prevents full insertion of the blades of an attachment plug having a face diameter of 49.2 mm (1-15/16 inches) and rectangular attachment plug having a face of 38.1 by 41.3 mm (1-1/2 by 1-5/8 inch).

Exception: This requirement does not apply to projections that prevent the blades of the attachment plug from making electrical contact with the female contacts of the convenience receptacle.

21.11 The location of the convenience receptacle must be such that it is not possible to bypass the grounding blade during insertion.

21.12 A Class A ground-fault circuit interrupter (GFCI) with open neutral protection shall be provided for general use convenience receptacles that are part of a fan intended to be used outdoors or in wet or damp locations. The convenience receptacle shall be located so that it is not wetted. See Sections 165 – 169 and 195.

21.13 A fan provided with a general use convenience receptacle intended for use in an outdoor location with the receptacle cover closed shall be provided with a self-closing cover and shall be marked in accordance with 81.10.

21.14 Supplementary overcurrent protection shall be provided for each general use convenience receptacle and shall be connected between the power supply cord and the receptacles. The overcurrent protective device shall comply with the requirements in the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077, for use with motor loads. The supplementary overcurrent protection device shall have been subjected to the Overload Test in the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077, tested for motor starting at 6 times the AC full load current rating.

Exception: A fuse that complies with the requirements in the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14, is not prohibited from being used as a supplementary overcurrent protection device.

21.15 A single-pole supplementary protection device shall be connected in the ungrounded (line) conductor of the supply circuit only. A double-pole device shall be connected on both the ungrounded and grounded (neutral) conductors such that when it operates, it opens both ungrounded and grounded conductors.

21.16 A supplementary protection device shall not be connected to the grounding conductor.

21.17 The ampere rating of the overcurrent protective device shall not be greater than 80 percent of the minimum anticipated branch circuit minus the fan rating.

21.18 A supplementary protection device shall not open during the Temperature Test, Section 46.

21.19 When a single overcurrent protective device does not protect all receptacle outlets, more than one overcurrent protective device shall be used, and each receptacle outlet shall be marked to indicate the rating of the overcurrent protective device connected to it. The total of the receptacle markings plus the fan rating shall not exceed 80 percent of the minimum anticipated branch circuit rating.

21.20 A fan employing a receptacle having a fuse that is intended to be replaced in the field shall be marked as specified in 81.8.

21.21 A product employing a convenience receptacle shall be marked with the rating of the receptacle. The rating shall correspond to the rating of the overcurrent protective device connected to it. See 80.1.8.

22 Motors

22.1 A motor shall comply with the construction requirements of the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

Exception: Control circuitry provided as part of a motor construction as described in Exception No. 1 to 23.1(c) shall be investigated in accordance with 23.4.

22.2 The Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, shall be amended in accordance with Table 22.1 for motors not enclosed, or partially enclosed, by the end product enclosure.

Table 22.1
Application of UL 1004-1 requirements

UL 1004-1 Requirement	UL 507 Amendment
Cord-Connected Motors, Section 15	Superceded by: UL 507, Clause 15
Factory Wiring Terminals and Leads, Section 17	Allowable option: UL 507, Clauses 14.2 – 14.4
Frame and Enclosure, Section 9	Allowable Option: UL 507, Clauses 7.1, 7.3, and 7.4
Ventilation Openings, Section 12	Allowable Option: UL 507, Sections 9, 10 and Clauses 7.1.4 – 7.1.7, where applicable
Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section 13	Allowable Option: UL 507, Sections 9 and 10
Protection Against Corrosion, Section 14	Outdoor Use – Superceded by: UL 507, Section 166.2 All Other Uses – Allowable Option: UL 507, Section 13

22.3 The Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, shall be amended in accordance with Table 22.2.

Table 22.2
Application of UL 1004-1 requirements

UL 1004-1 Requirement	UL 507 Amendment
Electrical Insulation, Section 22	Allowable Option: CTI values appropriate for the end use per UL 746C
Solid-State Controls, Clause 7.2	Allowable Option for Operating Only Controls: UL 507, Clause 86.2
Markings, Clause 43.1	Allowable Option: UL 1004-1, Clause 43.1 a), b), c), d), g), j), and m)

22.4 A motor shall be acceptable for the particular application, and shall be capable of handling the maximum normal load of the appliance without resulting in a risk of fire, electric shock, or injury to persons.

22.5 A motor winding shall resist the absorption of moisture as evaluated by the Humidity Conditioning Test, Section 53.

22.6 With reference to 22.5, film-coated wire and wire employing cotton over film coating are not required to be additionally treated to prevent absorption of moisture in an appliance not intended to be exposed to the weather – see 48.3.1 – 48.3.3. A treatment of the winding is required when the appliance is to comply with the requirements in 48.1.1, 48.1.2, and 48.3.1 – 48.3.3.

Exception: An appliance intended to be exposed to the weather is not required to have additional treatment of the winding, when:

a) The motor is totally enclosed, or

b) The motor has environmental related marking Rainproof (for Type 3R enclosure) or Raintight (for Type 3, 3S, 4, 4X, 6, or 6P enclosure) in accordance with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and

c) There is no water present on the motor windings as result of the Water Spray Test, Section 48.

Note: The requirement of 22.5 shall still be applied.

22.7 A brush holder assembly shall be constructed so that when a brush is worn out – no longer capable of performing its function – the brush, spring, and other part of the assembly is retained to the degree which does not result in:

a) An accessible dead-metal part becoming energized; and

b) A live part becoming accessible.

22.8 Motors for use in unattended areas shall be tested in accordance with Section 178, General, and Section 179A, Performance.

22.9 A bobbin-wound skeleton motor used in a ceiling-insert fan, wall-insert fan, or rangehood must comply with the following requirements:

a) The motor is to be provided with a coil wrap meeting the 5VA flammability requirements as defined by the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C;

b) The coil is to be completely wrapped with insulation at least 0.8 mm (1/32 inch) thick. This wrap is to employ at least two layers of insulation of minimum 0.4 mm (1/64 inch) thick;

c) The adhesive used to secure the coil wrap shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, as follows:

1) "As-received" test of UL 746C, Section 69.2. Average value of the bond strength shall be computed for comparison with subsequent test data. This value shall be no less than 16 oz force per inch width (0.175 N/mm or 18 g-f/mm).

2) Effects of temperature test of UL 746C, Section 69.3. Sample conditioning shall occur at the maximum temperature to which the adhesive is exposed within the end product under normal operation. Subsequent to conditioning, the bond strength must maintain 50% of its original value.

3) Effects of humidity test of UL 746C, Section 69.4. Subsequent to conditioning, the bond strength must maintain 50% of its original value.

Exception: With reference to (1) – (3), adhesive/coil wrap combinations that comply with Locked Rotor Cycling, Section 51, and Flagging, Section 52, are not required to comply with the adhesive requirements of UL 746C. This Exception does not apply to the mechanical securement requirement described in the subsequent paragraph.

In addition to this adhesive, the coil wrap is to be provided with a means for mechanical securement, such as securing the wrap end within the eye of the motor between the coil and motor frame;

d) The space between the bobbin and the wrap is not to exceed 0.8 mm total of both sides;

e) The space between the windings and the wrap is to be minimized, allowing for minimal air volume inside the coil wrap; and

f) The coil wrap is to possess a minimum electrical RTI of 90°C, but not less than the maximum temperature measured on the motor winding.

Exception No. 1: Coil wraps evaluated and employed as a major insulation component of a Class B insulation system are not required to meet the minimum electrical RTI requirements.

Exception No. 2: If separated from the motor windings by a suitable insulating material, the coil wrap is to possess a minimum electrical RTI of 90°C, but not less than the maximum temperature measured on the surface of the interposed insulating material.

23 Motor Protection

23.1 Over-temperature protection shall be provided for the motor of an appliance by one of the following:

a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3. The Running Heating Temperature Test shall be applied to belt-driven fan motors.

b) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2.

c) Electronic Protection complying with the Standard for Electronically Protected Motors, UL 1004-7. The Running Heating Temperature Test shall be applied to belt-driven fan motors.

Note: Line voltage converted to Class 2 within the motor electronics is not considered to waive the application of UL 1004-7.

Exception No. 1: A motor complying with the thermal protection requirements of UL 1004-3 or impedance protection requirements of UL 1004-2, independent of the electronic control, is not required to comply with the requirements for electronic protection. See 23.4.

Exception No. 2: A motor is not required to comply with the Electronic Protection requirements of UL 1004-7, provided:

a) The motor controller (solid-state), including solid-state overload protection, has been evaluated to the requirements of the Standard for Industrial Control Equipment, UL 508, or the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear – Part 4-2: Contactors and Motor-Starters – AC Semiconductor Motor Controllers and Starters, UL 60947-4-2, or

b) The motor drive incorporates overcurrent protection complying with the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1 with percent protection set as indicated in Table 26.1, and

c) The appliance is marked in accordance with 80.2.5.

d) Electronic protection complying with the tests of UL 1004-3 and the requirements for Protective Electronic Circuits in Supplement SB.

Exception: Three phase blower motors rated not more than 600 V, or single phase blower motors rated not more than 600 V and not less than 3/4 hp complying with Motor Overload Protection, Section 26, are not required to be provided integral thermal protection.

23.2 When a multispeed motor is provided with protection in accordance with these requirements, the protection shall accomplish the intended result at each setting of the speed-control device.

23.3 When a multispeed motor is not provided with protection in accordance with these requirements, and when the protection with which the appliance is provided upon installation does not function to protect the motor for one or more settings of the speed-control device, protection at each setting shall be provided as part of the appliance.

23.4 The control circuitry of a motor investigated in accordance with Exception No. 1 to 23.1(c) shall be considered an operating control, and shall comply with the applicable requirements of the:

a) Standard for Solid-State Fan Speed Controls, UL 1917,

b) *Deleted*

c) Standard for Industrial Control Equipment, UL 508,

d) Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1,

e) Standard for Automatic Electronic Controls – Part 1: General Requirements, UL 60730-1 (see 23.5),

f) Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear – Part 4-2: Contactors and Motor-Starters – AC Semiconductor Motor Controllers and Starters, UL 60947-4-2, or

g) Other equivalent standard intended to investigate the inherent electrical safety of controls and appropriate for the end-use environment.

23.5 Operating controls in accordance with 23.4 shall possess a minimum declared endurance cycling value of 6000. The minimum declared pollution degree shall be as described in 30.9.

23.6 When the running heating test is conducted with the motor installed within the appliance, testing shall be repeated under any operating condition that may reduce the cooling effect to the motor under test. Operating conditions include, but are not limited to, the type of impeller, variations in the impeller (such as number of blades, pitch, length) and enclosure variations (such as reduced volume/area, location and size of baffles).

24 Protective Devices

24.1 A protective device, the intended functioning of which requires replacement or resetting, shall be in a readily accessible location.

24.2 A protective device shall be inaccessible from outside the appliance without opening a door or cover.

Exception: This requirement does not apply to the operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts which project outside the enclosure.

24.3 A door or cover of an enclosure shall be hinged or attached in an equivalent manner when it gives access to any overload-protective device, the intended functioning of which requires renewal, or if it is necessary to open the cover in connection with the intended operation of the protective device.

24.4 A protective device shall not open the circuit during intended operation of the appliance.

24.5 In an automatic appliance, when breakdown of a capacitor that is not part of a permanent-split-capacitor motor or a part of a capacitor-start motor results in a risk of fire or electric shock, thermal or overcurrent protection shall be provided in the appliance.

25 Fuseholders and Fused Attachment Plugs

25.1 In addition to the applicable requirements in this standard, a fuseholder located in the enclosure of a unit shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9), and a fused attachment plug shall comply with the Standard for Attachment Plugs and Receptacles, UL 498, or the Standard for Cord Sets and Power-Supply Cords, UL 817.

25.2 The fused attachment plug, fuseholder, or in-line fuseholder shall be constructed such that there shall not be exposure of live parts during removal or replacement of the fuse(s). In addition, for a fused attachment plug, there shall not be exposure of live parts with the fuse cover partially open during 2.03 mm (0.08 inch) insertion into a receptacle. Exposure of live parts shall be determined by contact with the accessibility probe illustrated in Figure 10.1.

25.3 The fuse cover of a fuseholder, in-line fuseholder, or fused attachment plug or current tap shall not be detachable from the device as determined by the Fuseholder Cover Test, Section 66.

25.4 A fuseholder shall not employ insulation-piercing terminals.

26 Motor Overload Protection

26.1 As referenced in the Exception to 23.1, integral thermal protection is not required when the protection is provided by a separate device that is responsive to motor current and is rated or set to trip at

not more than the percentages of the motor nameplate full-load current rating specified in Column A of Table 26.1.

Table 26.1
Protective device activation level

Motor type	Maximum percent of full-load current rating	
	A	B
Motor with a marked service factor not less than 1.15	125	140
Motor with a marked temperature rise not more than 40°C (104°F)	125	140
Any other motor	115	130

26.2 When the overload device, selected in accordance with Column A of Table 26.1, is not sufficient to start the motor or to carry the load, the next higher size device shall be permitted to be used when the trip current of the overload device does not exceed the percentage values specified in Column B of Table 26.1.

26.3 A three phase motor shall be provided with overload protection as follows:

a) Three overcurrent units; or

b) Thermal protectors as described in 23.1(a), a combination of thermal protectors and overcurrent units, or another method of protection, where the specific protective arrangement has been investigated and found to provide protection under primary, single-phase failure conditions when power is supplied from transformers connected wye-delta or delta-wye.

26.4 The overload protection specified in 26.1 – 26.3 is not required to be provided as part of the unit when all of the following conditions exist:

a) The motor is to be field-wired to a separate circuit that does not supply any other loads within the unit;

b) The motor overload protection is part of a separate, field-provided motor controller that does not require wiring interconnection to the unit, except for the motor circuit; and

c) The product is marked in accordance with 80.2.6.

26.5 Fuses shall not be used as motor-overload protective devices unless the motor is protected by the fuse of the highest current rating that can be inserted in the fuseholder.

27 Switches, Including Motor Controllers

27.1 A switch or other control device shall:

a) Be acceptable for the application;

Exception: A switch or other device that controls a motor that has not been previously investigated for its suitability of controlling a motor shall be subjected to the Tests of Switches and Controls, Section 59.

b) Have a current and voltage rating not less than that of the load that it controls; and

c) Be located within the confines of the frame or enclosure of the appliance or be additionally protected so as to reduce the likelihood of contact by external objects.

Exception: The actuating part of a switch is not required to be located within the confines of the frame or enclosure.

27.2 A control considered as an operating control, other than as specified in 27.4, shall comply with the:

a) Standard for Fan Speed Controls, UL 1917;

b) Standard for Industrial Control Equipment, UL 508;

c) Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1;

d) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1;

e) The electronic circuits requirements in Supplement SB; or

f) Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear – Part 4-2: Contactors and Motor-Starters – AC Semiconductor Motor Controllers and Starters, UL 60947-4-2.

27.3 Switches shall comply with one of the following, as applicable:

a) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, with minimum 6000 cycles of endurance rating;

b) Standard for General-Use Snap Switches, UL 20; or

c) Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

Exception: Switching devices that comply with the appropriate UL standard for specialty applications (e.g. transfer switch equipment), industrial use (e.g. contactors, relays, auxiliary devices), or are integral to another component (e.g. switched lampholder) need not comply.

27.4 A switch or control intended to be located between the branch circuit and the appliance must comply with one of the following:

a) The Standard for General-Use Snap Switches,UL 20;

b) The Standard for Solid-State Fan Speed Controls, UL 1917; or

c) Other equivalent standards intended to determine compliance of the switches or controls for branch circuit installation.

27.5 The device box within which a switch as described in 27.4 is installed, and the accompanying coverplate, shall comply with the applicable standards within the UL 514 series: Metallic Outlet Boxes, UL 514A; Conduit, Tubing, and Cable Fittings, UL 514B; Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C; Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

27.6 With reference to the requirement in 27.1, the current rating of a switch that controls an inductive load, other than a motor, such as a transformer or a fluorescent-lamp ballast, shall not be less than twice the rated full-load current of the transformer or ballast, unless the switch is known to be acceptable for the particular application.

27.7 A manually operated, line-connected, single pole switch for appliance on-off operation shall not be connected to the conductor of the power supply cord intended to be grounded. Table 15.2 specifies the identification of the power supply cord conductor intended to be grounded.

27.8 A switch is considered to be acceptable for controlling a tungsten-filament lamp load when:

a) It has a T or L rating and a current rating at least equal to the tungsten-filament lamp load; or

b) It has an alternating-current rating at least six times, or a direct-current rating at least ten times that of the tungsten-filament lamp load.

27.9 A switch provided for the control of a fluorescent lamp and not integral with the lampholder shall have a current rating at least twice the primary rating of the ballast. Each ballast is to be considered as requiring its rated input current.

27.10 When an appliance provided with a direct-plug in power-supply cord and an attachment plug employs a motor rated more than 250 watts (1/3 horsepower) output, a motor controller – a device for starting and stopping the motor – shall be provided in the appliance.

27.11 A speed-control switch shall be provided with an appliance that employs a multispeed motor – a motor with a winding capable of various pole groupings.

27.12 The construction of a switch shall be such that only one circuit can be energized at a time.

Exception: A switch that is constructed to energize more than one circuit at a time shall not be employed unless it has been investigated and found acceptable for such use.

27.13 When a fan is provided with a timing or temperature device that automatically starts the fan, the automatic restarting of moving parts shall not result in a risk of injury to persons. See 81.2.

Exception: This requirement does not apply to a fan impeller having a diameter of 304.80 mm (12 inches) or less.

27.14 Automatic restarting of a fan provided with an automatically reset thermally actuated device, such as a room thermostat or a motor thermal protector, shall not result in a risk of injury to persons. See 81.2.

Exception: This requirement does not apply to a fan impeller having a diameter of 304.80 mm (12 inches) or less.

27.15 A permanently connected fan employing a factory wired component solid-state speed control shall include a positive marked “off” position provided by an air-gap-type switch that complies with the applicable requirements in the Standard for General-Use Snap Switches, UL 20, the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or the equivalent. This marking shall be represented by the word “off”, the symbol “O”, or a visual indicator.

Exception No. 1: This requirement does not apply to a fan speed control with the function of electronic disconnection that is additionally evaluated as a protective control in accordance with the Standard for Automatic Electric Controls - Part 1: General Requirements, UL 60730-1.

Exception No. 2: An air-gap-type switch is not required when the factory wired solid state speed control de-energizes only circuits that involve open circuit potentials less than 30 V ac (42.4 V peak), and where the continuous current flow through a 1500 ohm resistor connected across the potential does not exceed 0.5 mA.

Exception No. 3: Electromechanical relays complying with the Standard for Industrial Control Equipment, UL 508, or the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-

Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1, provide equivalent air gap isolation to meet the requirement in 27.15.

Exception No. 4: The air gap within wall controls/switches is acceptable as the air gap if the product is provided with installation instructions as specified by 88A.1 or 93.18.

Exception No. 5: For appliances, with motor rated 1/8 hp (100 W) or less, the marked "off" position is not required.

Exception No. 6: This requirement does not apply to circuits that comply with the requirements in Supplement SB. For the purposes of applying Supplement SB, loss of the function of an electronic disconnect shall be considered a Dangerous Malfunction

28 Interlocks

28.1 A moving part that could cause injury to a person is considered to be guarded if protected by a cover with an interlock that complies with one of the following conditions:

a) The part stops moving within 3 seconds after the cover is opened, or

b) The interlock prevents the cover from being opened until the part stops moving.

28.2 Operation of an interlock in normal use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

28.3 An interlock shall be located so that unintentional operation is unlikely. The interlock shall not be readily defeatable without damaging the product, or without making wiring connections or alterations.

28.4 An interlock that is required to reduce a risk of electric shock or injury to persons shall withstand 100,000 cycles of operation controlling a load not less than that controlled in the air cleaner, and shall function normally upon completion of the test.

28.5 If an electronic control provides the functionality required for safety interlocks as defined by 28.1, the circuit providing the required safety functionality shall be additionally evaluated as a protective control in accordance with the Standard for Automatic Electric Controls – Part 1: General Requirements, UL 60730-1. See Table 28.1.

Exception: Circuits that meet the parameters of Table 28.1 and the requirements for Protective Electronic Circuits in Supplement SB.

Table 28.1
Application of UL 60730-1

FMEA	Conduct a failure-mode and effect analysis (FMEA) confirming that the interlock function maintains compliance with 28.1 or that the control maintains compliance with the Exception to 90.1 under single fault conditions.
Risk Mitigation	A control becoming permanently inoperative and disconnecting power meets the criteria for mitigating the risk.
Operating Ambient	Operating ambient shall be determined in a temperature test (Clause 46) of the appliance.

Table 28.1 Continued on Next Page

Table 28.1 Continued

Endurance Test	100,000 cycles
Pollution Degree	Pollution degree as defined in 30.9
Overvoltage Category	Overvoltage Category II
Software Class	Class B (if relied upon for compliance with 28.1 or the Exception to 90.1)
Radio-frequency electromagnetic field immunity	Immunity to radiated electromagnetic fields – Test Level 3
Fast Transient Bursts	Test level 3 is applicable for signal and control lines. Test level 4 is applicable for the power supply lines. Bursts are applied 1 min. in positive polarity and 1 min. in negative polarity.
Surge Immunity	Installation Class 3.
Electrostatic Discharge	Severity Level 3

29 Capacitors

29.1 A motor start or run capacitor shall comply with the construction requirements in the Standard for Capacitors, UL 810.

29.2 A capacitor, mounted in an application not intended to be totally enclosed, shall be housed within an enclosure that protects the capacitor against mechanical damage and prevents the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The enclosure shall comply with the requirements in Section 7, Frame and Enclosure.

29.3 Except for a cord-connected appliance rated for a nominal 120-volt supply – see 41.1 – the total capacitance of capacitors connected from one side of the line to the frame or enclosure of an appliance shall not result in the flow of more than 5 milliamperes in the grounding conductor when the frame or enclosure is connected to ground.

29.4 Capacitors connected across-the-line or line to ground in other than a secondary circuit shall comply with Section 47, Dielectric Voltage Withstand Test.

Exception: This requirement does not apply to a capacitor that does not exceed its temperature rating during the Temperature Test, Section 46, and complies with the Dielectric Voltage Withstand Test of the Standard for Electromagnetic Interference Filters, UL 1283.

29.5 A capacitor connected between two line conductors in a primary circuit, or between one line conductor and the neutral conductor or between primary and accessible secondary circuits or between the primary circuit and protective earth (equipment grounding conductor connection) shall comply with one of the subclasses of the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, and shall be used in accordance with its rating. Details for damp heat, steady state test can be found in 4.12 of UL 60384-14.

Exception: This requirement does not apply to capacitors that comply with the Dielectric Voltage Withstand Test, Insulation Resistance Test, and Endurance Test of the Standard for Electromagnetic Interference Filters, UL 1283.

29.6 A motor starting or running capacitor shall be rated for the appropriate voltage. The maximum available fault current (AFC) to which it can be subjected shall comply with one of the following as applicable:

a) A value of 5,000 A minimum when connected directly across the line;

b) For capacitors connected in series with a motor coil, the maximum current available to a short-circuited capacitor, when connected in series with the motor coil energized under locked rotor conditions;

c) For a dry metallized-polypropylene film capacitor operating at less than or equal to 330 VRMS, a maximum AFC rating is not required; or

d) For electrolytic type capacitor, a maximum AFC rating is not required.

30 Spacings

30.1 The spacings between field-wiring terminals of opposite polarity, and between a wiring terminal and any other uninsulated metal part (dead or live) not of the same polarity, shall not be less than that specified in Table 30.1. See 14.4.1.

Exception No. 1: The spacing requirements in Table 30.1 do not apply to the inherent spacings of a component of an appliance, such as a switch. Such spacings are to comply with the requirements for the component in question.

Exception No. 2: Spacings on printed wiring board assemblies may comply with the requirements in 30.8 and Table 30.3.

Exception No. 3: Circuits that comply with the requirements for Secondary Circuits, Section 31, are not required to be evaluated for spacings. The spacings between these circuits and other circuits shall comply with Table 30.1 – Table 30.3 as applicable.

Table 30.1
Minimum required spacings at field-wiring terminals

Potential involved, volts	Minimum spacings, mm (inch)		
	Between field-wiring terminals, through air or over surface	Between field-wiring terminals and other uninsulated metal parts not always of the same polarity[a]	
		Over surface	Through air
250 or less	6.35 (1/4)	6.35 (1/4)	6.35 (1/4)
More than 250	12.70 (1/2)[b]	12.70 (1/2)[b]	9.52 (3/8)

[a] Applies to the sum of the spacings involved where an isolated dead part is interposed.

[b] A spacing of not less than 9.52 mm (3/8 inch), through air and over surface, is acceptable at wiring terminals in a wiring compartment or terminal box if the compartment or box is integral with a motor.

Table 30.2
Minimum required spacings at other than field-wiring terminals

Potential involved, volts	Minimum spacings, mm (inch)							
	An appliance employing a motor having a diameter of 177.80 mm (7 inches) or less[a]				An appliance employing a motor having a diameter of more than 177.80 mm (7 inches)[a]			
	Over surface		Through air		Over surface		Through air	
0 – 50	1.59	(1/16)	1.59	(1/16)	6.35[c]	(1/4)	3.18[c]	(1/8)
51 – 125	2.38[b]	(3/32)	2.38[b]	(3/32)	6.35[c]	(1/4)	3.18[c]	(1/8)
126 – 250	2.38	(3/32)	2.38	(3/32)	6.35[c]	(1/4)	6.35[c]	(1/4)

Table 30.2 Continued on Next Page

Table 30.2 Continued

Potential involved, volts	Minimum spacings, mm (inch)							
	An appliance employing a motor having a diameter of 177.80 mm (7 inches) or less[a]				An appliance employing a motor having a diameter of more than 177.80 mm (7 inches)[a]			
	Over surface		Through air		Over surface		Through air	
251 – 600	12.70[c]	(1/2)	9.52[c]	(3/8)	12.70[c]	(1/2)	9.52[c]	(3/8)

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

[b] For an appliance employing only motors rated 248.57 watts or less, these spacings may be not less than 1.59 mm.

[c] Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 2.38 mm 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.

Table 30.3
Minimum required spacings on printed-wiring board assemblies[a,e]

Voltage available[c]	Energy available	Minimum spacings		Conformal coating
		mm	(inch)	
51 – 600	Unlimited	0.8	(1/32)	d
0 – 50[b,c]	Unlimited	0.8	(1/32)	d

[a] The minimum spacings are required between live parts of opposite polarity. Spacings between live parts and dead metal shall comply with Table 30.1 or Table 30.2 as applicable.

[b] A coating is not required when the board assembly is in compliance with the Exception to 30.8.

[c] For peak voltages and battery voltages multiply applicable rms voltage by 1.4.

[d] In accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[e] A printed-wiring board intended to be completely encapsulated in a potting compound or epoxy in accordance with UL 746C shall not have any spacing less than 0.8 mm (1/32 inch).

30.2 Spacings, other than at field-wiring terminals, between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead-metal part, shall not be less than the applicable value specified in Table 30.2. When an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or when a movable dead-metal part is in proximity to an uninsulated live part, the construction shall be such that the minimum acceptable spacing will be maintained.

Exception: The spacing requirements in Table 30.2 do not apply to the inherent spacings of a component of an appliance, such as a switch. Such spacings are to comply with the requirements for the component in question.

30.3 An uninsulated conductor of a rotor circuit shall be regarded as a dead-metal part with respect to the stator circuit, and the required spacing shall be provided between uninsulated stator and rotor conductors.

30.4 In the application of 30.2, 47.1, and Table 30.2 to an appliance employing a motor not rated in watts, Tables 430.147 through 430.150 of the National Electrical Code, ANSI/NFPA 70, are to be used as applicable to determine the relationships between watts and full-load current for motors.

30.5 At terminal screws and studs to which connections are made in the field by wire connectors, eyelets, or the like described in 14.4.1, spacings shall not be less than those specified in Table 30.2 with the connectors, eyelets, or the like, in such position that minimum spacings – opposite polarity and to dead metal – exist.

30.6 A barrier or liner of vulcanized fiber or similar material employed in lieu of spacings shall be of a material acceptable for the application and shall not be less than 0.8 mm (1/32 inch) thick.

Exception No. 1: A barrier or liner used in conjunction with not less than one-half the required spacing through air, shall not be less than 0.4 mm (1/64 inch) thick, only when the barrier or liner is of acceptable insulating material, resistant to moisture, of adequate mechanical strength if exposed or otherwise subjected to mechanical damage, secured in place, and located so that it is not damaged by operation of the appliance in service – particularly arcing.

Exception No. 2: Insulating material having a thickness less than that specified shall not be used unless, upon investigation, it is found to be acceptable for the particular application.

30.7 Motor spacings shall comply with the spacing requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

30.8 Spacings on a printed wiring board assembly that are less than indicated in Table 30.2:

a) Shall be provided with a coating and spacings as specified in Table 30.3; or

Exception: A coating is not required when the available rms voltage is 50 volts or less and the board is located in such a manner that it is not readily subject to contamination by dust or electrolyte.

b) Shall comply with the requirements for creepages and clearances as defined by the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

30.9 The spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, shall be amended as follows:

a) For indoor only appliances, the Pollution Degree shall be 2;

Exception: For air-filtering appliances the Pollution Degree shall be 3;

b) For indoor/outdoor fans and printed wiring boards in the airstream of a cooking area, ceiling insert, or wall-insert fan, the Pollution Degree shall be 3.

c) Hermetically sealed or encapsulated enclosures, or conformally-coated printed-wiring boards are identified as Pollution Degree 1;

d) Appliances shall be rated Overvoltage Category II;

e) To apply Clearance B (controlled overvoltage), an appliance shall be provided with an integral overvoltage device or system;

f) All printed-wiring boards employed with products rated 250 V or less have been determined to have a minimum Comparative Tracking Index (CTI) PLC of 3; and

g) All printed-wiring boards employed with products rated 400 V or less have been determined to have a minimum CTI PLC of 2.

30.10 The overcurrent protective device mentioned in 31.4.4 or 31.5.4 shall:

a) Not be of the automatic reset type;

b) Be trip-free from the reclosing mechanism when of the manual reset type; and

c) Not be interchangeable with one of a larger current rating when it is a renewable device.

31 Secondary Circuits

31.1 General

31.1.1 A secondary circuit shall comply with the requirements for one of the following types of secondary circuits:

a) A Class 2 circuit;

b) A limited voltage/current circuit;

c) A limited energy circuit;

d) A limiting impedance circuit; or

e) The requirements for electronic circuits in Supplement SB.

31.1.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this Standard shall be constructed in accordance with the Standard for Optical Isolators, UL 1577, and shall be able to withstand for 1 minute, without breakdown, an ac dielectric voltage withstand potential equal to 1000 V plus twice rated voltage between the input and output circuits.

31.1.3 A power switching semiconductor device that is relied upon to provide isolation to ground shall be constructed in accordance with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted at a dielectric potential of 1000 V plus twice rated voltage for 1 minute.

31.2 Difference between the level of evaluation required within each type of secondary circuit

31.2.1 The following applies to secondary circuits that comply with the Class 2 requirements of 31.3.1 or the limited voltage/current requirements of 31.4.1 – 31.4.7:

a) Components located within these circuits are not required to be evaluated.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be evaluated. However, spacings from these circuits to other circuits shall be in accordance with Spacings, Section 30.

c) These circuits are not prohibited from being accessible from outside the enclosure.

31.2.2 The following applies to secondary circuits that comply with the limited energy requirements of 31.5.1 – 31.5.4 circuit requirements and that involve open circuit potentials less than or equal to 30 V ac or 42.4 V peak:

a) Components located within these circuits are not required to be evaluated.

Exception: Printed-wiring boards shall be evaluated in accordance with Section 32, Printed-Wiring Boards. Wiring shall be evaluated in accordance with Section 19, Internal Wiring – Electrical Connections.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be evaluated. However, spacings from these circuits to other circuits shall be in accordance with Section 30, Spacings.

c) These circuits shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be evaluated.

31.2.3 The following applies to secondary circuits that comply with the limited energy requirements of 31.5.1 – 31.5.4 and that involve open circuit potentials in excess of 30 V ac or 42.4 V peak:

a) Components located within these circuits are not required to be evaluated.

Exception: Printed-wiring boards shall be evaluated in accordance with Section 32, Printed-Wiring Boards. Wiring shall be evaluated in accordance with Section 19, Internal Wiring – Electrical Connections. The effects of heat generating power components on adjacent components such as printed wiring boards and wiring shall be evaluated in accordance with the temperature requirements in Temperature Test, Section 46.

b) Spacings located within these circuits are not required to be evaluated. However, spacings from these circuits to earth ground or to the enclosure and spacings from these circuits to other circuits shall be in accordance with Spacings, Section 30.

c) These circuits shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be evaluated.

31.2.4 The following applies to secondary circuits that comply with the limiting impedance requirements of 31.6.1 – 31.6.2:

a) Components located within these circuits are not required to be evaluated.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be evaluated. However, spacings from these circuits to other circuits shall be in accordance with Section 30, Spacings.

c) These circuits are not prohibited from being accessible from outside the enclosure.

Exception: Circuits supplied from a limiting impedance that complies with Exception No. 1 to 31.6.2 shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be evaluated.

31.3 Class 2 circuit requirements

31.3.1 A Class 2 circuit shall be supplied by an isolating source that complies with the requirements in the Standard for Class 2 Power Units, UL 1310, or the requirements in the Standards for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

31.4 Limited voltage/current circuit requirements

31.4.1 A limited voltage/current circuit shall be supplied by an isolating source such that the maximum open circuit voltage potential available to the circuit is not more than 30 V ac or 42.4 V peak and the current available is limited to a value not exceeding 8 amperes measured after 1 minute of operation. The secondary winding of an isolating type transformer meets the intent of compliance with this requirement. The transformer shall comply with the requirements in the appropriate UL Standards for Transformers.

31.4.2 With reference to these secondary voltage and current limits, these measurements are to be made as follows:

a) The input to the source of that secondary is to be connected as intended;

b) The maximum open circuit voltage potential available to the secondary circuit under consideration is to be measured across the source of that secondary; and

c) The current available to the secondary circuit under consideration is to be measured by connecting a variable resistive load across the source of that secondary and then varying the load until an available current of 8 amperes is obtained for 1 minute of operation. When an available current of 8 amperes is not obtained under any condition of loading, up to and including a short circuit, then the test is to be discontinued for that circuit.

31.4.3 For a transformer, only one secondary circuit of a multiple secondary transformer is to be tested at a time and all other secondaries not under test are to be loaded as intended. The voltage and current measurements are to be made directly across the secondary output terminals of the transformer. When a tapped transformer winding is used to supply a full-wave rectifier, the measurements are to be made from either end of the winding to the tap. When the transformer is used as part of a switching-type power supply, the voltage and current measurements are to be made after the transformer secondary winding rectification means.

31.4.4 A secondary fuse or other such secondary circuit protective device used to limit the available current in accordance with 31.4.1, shall be rated at not more than the values specified in Table 31.1. See 30.10.

Table 31.1
Rating for fuse or circuit protective device

Open circuit volts (peak)	Amperes
0 – 20	5.0
Over 20 – 30	100/V[a]

[a] V is defined as the peak open circuit voltage.

31.4.5 The secondary circuit protective device referenced in 31.4.4 is not prohibited from also being provided in the primary circuit. When provided in the primary circuit, there are no restrictions on the current rating of the protective device as long as it limits the available secondary current in accordance with Table 31.1.

31.4.6 When a protective device is used as specified in 31.4.4 or 31.4.5, this protective device shall comply with the requirements in Section 30, Spacings, and shall be provided with an adjacent replacement marking and replacement instructions that include the required voltage and current rating. The printed wiring board, wiring, and spacings prior to the point at which the voltage and current are suitably limited shall comply with the requirements of this Standard.

31.4.7 A fixed impedance (such as a component or grouping of components in the same circuit) or a regulating network (such as used in a switching type power supply) meets the intent of limiting the voltage and/or the available current in accordance with 31.4.1. Such a fixed impedance or regulating network shall be able to function under single component fault conditions.

31.5 Limited energy circuit requirements

31.5.1 A limited energy circuit shall be supplied by an isolating source such that the maximum volt-ampere capacity available to the circuit is 200 volt-amperes or less at a maximum open circuit voltage potential of 100 V ac. The secondary winding of an isolating type transformer meets the intent of

compliance with this requirement. The transformer shall comply with the requirements in the appropriate UL Standard for Transformers.

31.5.2 With reference to the secondary voltage and volt-ampere capacity limits, the measurements are to be made as follows:

a) The input to the source of that secondary is to be connected as intended;

b) The maximum open circuit voltage potential available to the secondary circuit under consideration is to be measured across the source of that secondary; and

c) The maximum volt-ampere capacity available to the secondary circuit under consideration is to be measured by connecting a variable resistive load across the source of that secondary and then measuring the voltage and current while varying the resistive load from open circuit to short circuit in 1-1/2 to 2-1/2 minutes. The maximum available volt-ampere capacity is then calculated by multiplying the simultaneously measured values of secondary voltage and secondary current.

31.5.3 For a transformer, only one secondary circuit of a multiple secondary transformer is to be tested at a time and all other secondaries not under test are to be loaded as intended. The voltage and volt-ampere capacity measurements are to be made directly across the secondary output terminals of the transformer. When a tapped transformer winding is used to supply a full-wave rectifier, the measurements are to be made from either end of the winding to the tap. When the transformer is used as part of a switching-type power supply, the voltage and volt-ampere capacity measurements are to be made after the transformer secondary winding rectification means.

31.5.4 A primary or secondary circuit fuse or other such circuit protective device meets the intent of limiting the maximum available volt-ampere capacity in accordance with 31.5.1. While there are no restrictions on the current rating of this protective device as long as it limits the available secondary volt-ampere limit in accordance with 31.5.2, the protective device shall comply with the requirements of this Standard and shall be provided with an adjacent replacement marking or replacement instructions that includes the required voltage and current rating. The printed wiring board, wiring, and spacings prior to the point at which the voltage and volt-ampere capacity are suitably limited shall comply with the requirements of this Standard.

31.6 Limiting impedance circuit requirements

31.6.1 A limiting impedance circuit shall be supplied by an impedance that complies with the following:

a) The calculated power dissipation of the impedance, as the result of a direct short applied across the circuit downstream of the impedance, does not exceed the power rating of the impedance;

b) The power dissipation of the impedance is not greater than 15 Watts; and

c) There does not exist a risk of shock, as defined in 2.3.16, downstream of the impedance.

Exception: A limiting impedance circuit is not prohibited from being supplied by an impedance that complies with the following:

a) The impedance shall be rated such that the calculated power dissipation of the impedance, as the result of a direct short applied across the circuit downstream of the impedance, exceeds the power rating of the impedance and is still less than 15 Watts;

b) The impedance shall not open or short when subjected to the effects of a direct short applied across the circuit downstream of the impedance. The method for setting up this limiting impedance test is the same as the method for setting up the Breakdown of Components Test, Section 65; and

c) There does not exist a risk of shock, as defined in 2.3.16, downstream of the impedance.

31.6.2 The limiting impedance referred to in 31.6.1 shall be able to function under single component fault conditions.

Exception No. 1: When the circuit limited by this impedance is enclosed, this limiting impedance is not required to function under single component fault conditions.

Exception No. 2: A single resistor serving as a limiting impedance is determined to comply with this requirement without further investigation.

Exception No. 3: A single capacitor serving as a limiting impedance is determined to comply with this requirement without further investigation when the capacitor complies with requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

32 Printed-Wiring Boards

32.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796, including direct support criteria, and shall be classed V-0, V-1, or V-2 in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in 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.

32.2 A resistor, capacitor, inductor, or other part that is mounted on a printed-wiring board to form a printed-wiring assembly shall be secured so that it is not displaced to result in a risk of electric shock or fire by a force typically exerted during assembly, normal operation, or servicing of the fan.

32.3 Consideration is to be given to a barrier or a partition that is part of the device and that provides mechanical protection and electrical insulation of a component connected to the printed-wiring board.

33 General Purpose Transformer – Insulation Systems

33.1 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in Table 33.1 at the thicknesses specified are permitted to be used without further evaluation.

33.2 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 33.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 33.3.

33.3 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall be unfilled or glass-reinforced nylon, polycarbonate, polybutylene terephthalate, polyethylene terephthalate, phenolic or acetal, and shall have a relative or generic thermal index for electrical properties of 105°C minimum. Leads shall be rated 90°C minimum.

Exception: Other polymeric materials used in a Class 105 (A) insulation system shall comply with Thermal Aging, Section 68.

33.4 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

33.5 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

Table 33.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	mm	(inches)
Vulcanized fiber	0.71	(0.028)
Polyethylene terephthalate film	0.18	(0.007)
Cambric	0.71	(0.028)
Treated cloth	0.71	(0.028)
Electrical grade paper	0.71	(0.028)
Mica	0.15	(0.006)
Aramid paper	0.25	(0.010)

34 Electronic Circuits

34.1 Malfunction of a component such as a diode, a transistor, a thyristor, an electrolytic capacitor, an integrated circuit, an optical isolator, or other solid-state device (any device whose operation is dependent upon any combination of optical, electrical, or magnetic phenomena within a solid) that has not been investigated for reliability and determined to be reliable shall not result in a risk of fire, electric shock or injury to persons when subjected to the Component Breakdown Test in Section 65.

Exception No. 1: A component located in the following circuits is not required to be subjected to the Component Breakdown Test:

a) Circuits that comply with the requirements for Secondary Circuits, Section 31;

b) A circuit that has been investigated as a protective control in accordance with the Standard for Automatic Electric Controls - Part 1: General Requirements, UL 60730-1, for reliability; and

c) Circuits used in low voltage component fans.

Exception No. 2: This requirement does not apply to resistors, non-electrolytic capacitors, inductors, transformers, electromechanical devices such as switches and relays, and optical isolators that comply with the applicable requirements as specified elsewhere in this Standard.

Exception No. 3: This requirement does not apply to circuits evaluated to the requirements in Supplement SB.

34.2 Compliance with 34.1 requires an analysis of the circuit to determine whether malfunction of a component results in a risk of fire, electric shock or injury to persons. This analysis requires the opening and short circuiting of a component (electrolytic capacitor, transistor junction, and the like) and observation of the ultimate results of the simulated malfunction or breakdown. Only one condition of simulated malfunction or breakdown is to be imposed at a time.

35 Grounding

35.1 General

35.1.1 In addition to the requirements specified in 35.1 – 35.3, an appliance shall comply with the applicable requirements in 14.4.1 – 14.4.10, 14.5.5, and 14.5.6.

35.1.2 Electrical continuity shall be provided between all exposed dead-metal parts and all dead-metal parts within the enclosure that are exposed to contact during any user-servicing operation and that can become energized and:

a) The equipment grounding terminal or lead, and to the metal surrounding the knockout, hole, bushing, or metallic fitting (at the end of flexible armored cable for attachment to a field-provided metallic outlet box) provided for field power-supply connection for an appliance intended for permanent electrical connection; or

b) The point of connection of the grounding conductor of the power-supply cord of an appliance equipped with a power-supply cord of the grounding type. See 35.3.1.

35.1.3 With reference to the requirement in 35.1.2, two pieces of enameled or painted sheet metal are not considered to be adequately bonded together unless measures are taken to penetrate the enamel or paint at points of bonding.

35.1.4 Sheet metal screws shall not be used for:

a) Field connection of equipment grounding conductors to an enclosure; and

b) Connection of a factory-provided grounding lead to an enclosure.

For the purposes of this requirement, a sheet metal screw is defined as a screw with a thread pitch that exceeds the thickness of the sheet metal and is designed to engage an unextruded, unthreaded hole in the metal.

35.1.5 Removal of a motor or light in a wall-insert fan, a ceiling-insert fan, or a ceiling-insert fan/light combination shall not result in disconnection of the field wired equipment grounding conductor or internal bonding jumper.

Exception: Disconnection of an internal bonding jumper made by the plug and receptacle disconnection meets the intent of this requirement.

35.1.6 The means for grounding continuity shall be constructed so that contact pressure is not transmitted through insulating material which is liable to shrink or to distort unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

35.1.7 The grounding means shall not be used for any other purpose than to provide a grounding conductor path.

35.2 Permanently connected appliances

35.2.1 An equipment-grounding connection, a grounding conductor, an enclosure, a frame, a component-mounting panel, or any other part connected to earth ground shall not carry current except during an electrical fault.

Exception: A permanently connected appliance provided with double insulation in accordance with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, need not comply with this requirement.

35.2.2 The equipment-grounding terminal shall secure an equipment grounding conductor of a size acceptable for the application in accordance with the National Electrical Code, ANSI/NFPA 70. The terminal shall not be smaller than No. 10 (4.8 mm diameter).

35.2.3 A pressure wire connector provided for an equipment-grounding conductor shall comply with the applicable requirements in the Standard for Wire Connectors, UL 486A-486B. A connector not covered by UL 486A-486B shall exhibit, upon investigation, performance equivalent to that specified in that standard.

35.2.4 A product intended for mounting in a flush-device box shall be so constructed such that electrical continuity is provided between a metal faceplate and the equipment grounding means in the box when the device and the faceplate are installed in the intended manner.

35.3 Cord-connected appliances

35.3.1 A power-supply cord of an appliance intended for use on a circuit operating at a potential of more than 150 volts to ground shall include an equipment-grounding conductor.

Exception: Appliances with no parts requiring electrical continuity in accordance with 35.1.2 are not required to be provided with an equipment grounding conductor.

35.3.2 A cord-connected appliance provided with double insulation in accordance with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, is not required to be provided with an equipment-grounding conductor. Also see 15.1.7.

35.3.3 A power-supply cord of an evaporative cooler, a stationary fan, or a fan intended to be used, or that may be used, outdoors in accordance with the literature provided with the fan shall include an equipment-grounding conductor.

Exception: Appliances with no parts requiring electrical continuity in accordance with 35.1.2, and having no dead metal parts likely to become energized which are in contact with water, are not required to be provided with an equipment grounding conductor.

35.3.4 An equipment-grounding conductor of a flexible cord shall be:

a) Finished to show a green color with or without one or more yellow stripes;

b) Connected to the grounding member of an attachment plug of the grounding type; and

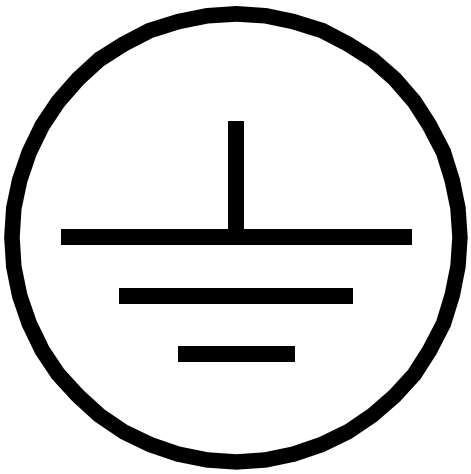
c) Connected to the dead-metal parts mentioned in 35.1.2 by a screw or other means that is not removed during servicing. Solder alone shall not be used for making this connection.

35.3.5 The screw mentioned in 35.3.4(c) shall be of corrosion-resistant metal, or shall be adequately protected against corrosion, and shall not be smaller than No. 10 (4.8 mm diameter). A lock washer or equivalent means shall be employed to prevent the screw from becoming loosened by vibration.

35.3.6 A pressure wire connector intended solely for the connection of an equipment-grounding conductor shall be identified by being colored green, marked "G," "GR," "Ground," "Grounding," the grounding symbol illustrated in Figure 35.1, or the like, or by a marking on a wiring diagram provided on the fan. The pressure wire connector shall be located so that it is not removed during intended servicing of the fan.

Figure 35.1

Grounding symbol



35.4 Grounding for low-voltage power-limited circuits

35.4.1 The circuit grounding conductor shall not be smaller than the transformer output conductors, and in no case smaller than 14 AWG copper. The conductor shall be bare or insulated with green (or green with one or more yellow stripes) insulation.

35.5 Fans employing convenience receptacles

35.5.1 A metallic enclosure and other dead metal parts of a fan employing a convenience receptacle that are exposed to contact by persons shall be conductively connected to the grounding conductor of the power-supply cord.

Exception: A small metal part, such as an adhesive-attached foil label or a screw, that is on the exterior of the enclosure and separated from all electrical components by grounded metal or is electrically isolated from all components is not required to be connected to the grounding conductor of the power supply cord.

35.5.2 The conductive connection of parts required by 35.5.1 shall be made by a clamp, bolt, screw, braze, weld, or an equivalent positive means that cannot be loosened from the outside and is not prohibited from including a corrosion resistant strap or jumper. Mechanical connections shall be secured. A solder connection is not prohibited from being used when the power supply cord grounding lead is mechanically secure to the enclosure in accordance with 19.12. A push-in (screwless), quick-connect, or similar friction-fit connector shall not be used for this connection.

35.5.3 Connections in the equipment grounding conductor path from the convenience receptacle grounding contact to the equipment grounding conductor of the power supply cord shall be welded, bolted, mechanically secured and soldered, or made by equivalent positive means. A quick-connect, or similar friction-fit connector, shall not be used in the grounding conductor path.

35.5.4 The yoke or faceplate mounting screws of the convenience receptacle shall not be used to provide or maintain the grounding means of the convenience receptacle.

35.5.5 When a convenience receptacle used on a fan is provided with a grounding screw, this screw shall be used to provide the ground connection to the convenience receptacle.

36 Filters

36.1 A fan intended for connection to a duct and employing one or more filters that have not been determined to be acceptable, with or without one or more acceptable filters, is acceptable if, when tested, the filter in a single filter fan or the assembly of filters in a multifilter fan is found to be equivalent in performance to the filter specified for that fan in 36.2. A test on an assembly of filters is to be conducted with the filters mounted in the intended manner.

36.2 A filter provided with an air filtering appliance intended for connection to a duct shall comply with the Standard for Air Filter Units, UL 900.

36.3 When used with reference to an evaporative cooler, the term filter signifies a moisture-bearing evaporator or wick for introducing moisture into the air stream.

37 Accessories

37.1 Use of an accessory that is furnished with a fan shall not cause a risk of fire, electric shock, or injury to persons.

38 Button or Coin Cell Batteries of Lithium Technologies

38.1 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more coin cell batteries of lithium technologies shall comply with the Standard for Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A, if the appliance or any accessory:

a) Is intended for use with one or more single cell batteries having a diameter of 32 mm (1.25 in) maximum with a diameter greater than its height; and

b) The appliance is intended for household use.

Exception No. 1: This requirement is not applicable to appliances and accessories intended for use where the battery is not intended to be replaced and is not referenced in instructions and markings.

Exception No. 2: This requirement is not applicable to appliances and accessories where the battery compartment would be located at least 2.1 m (7 foot) above the floor when the fan is installed as intended.

39 Lasers

39.1 A product employing a laser falling within the scope of the Code of Federal Regulations (CFR), Title 21, Part 1040 shall be compliant with the regulation.

39.2 With reference to 39.1, compliance of laser products with the Code of Federal Regulations (CFR), Title 21, Part 1040, shall be determined by:

a) Determining the Class of the laser product and the Class of the radiation emitted by the laser product (as defined in the CFR) from the manufacturer's Center for Devices and Radiological Health (CDRH) product report;

b) Verifying that the manufacturer’s markings and labels having the information specified in the CFR are affixed on the laser product (as defined in the CFR);

c) Determining that the corresponding construction features, such as protective housing, interlocks, and similar features, are provided in accordance with the CFR;

d) Determining that the resulting construction complies with the construction requirements of this standard; and

e) Verifying that the manufacture's safety instructions required by the CFR are provided with the laser product (as defined in the CFR).

PERFORMANCE – ALL APPLIANCES

40 Test Voltages

40.1 Unless otherwise specified, products shall be tested at a potential in accordance with Table 40.1 for each test described.

Table 40.1
Test voltages

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 ±1.5 percent.

41 Leakage Current Test

41.1 A cord-connected product rated for a nominal 240-volt or less supply shall be tested in accordance with 41.3 – 41.6. Leakage current shall not exceed:

a) 0.5 milliampere for an ungrounded 2-wire product;

b) 0.5 milliampere for a grounded, 3-wire, portable product; and

c) 0.75 milliampere for a grounded, 3-wire, product:

1) Employing a standard attachment plug rated 20 amperes or less; and

2) Intended to be fastened in place or located in a dedicated space.

41.2 Leakage current refers to all currents, including capacitively coupled currents, that are conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

41.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure determined to reduce the risk of electric shock as defined in 10.1 – 10.3. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to involve a risk of electric shock. When all accessible surfaces are bonded together and

connected to the grounding conductor of the power-supply cord, the leakage current can be measured between the grounding conductor and the grounded supply conductor.

41.4 When a polymeric material or conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil having an area of 10 by 20 centimeters (3.9 by 7.9 inches) in contact with the surface. When the surface has an area of less than 10 by 20 centimeters (3.9 by 7.9 inches), the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance.

41.5 The measurement circuit for leakage current is to be as illustrated in Figure 41.1. The measurement instrument is defined in (a) – (d). The meter that is actually used for a measurement need not only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used is not required to have all the attributes of the defined instrument:

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

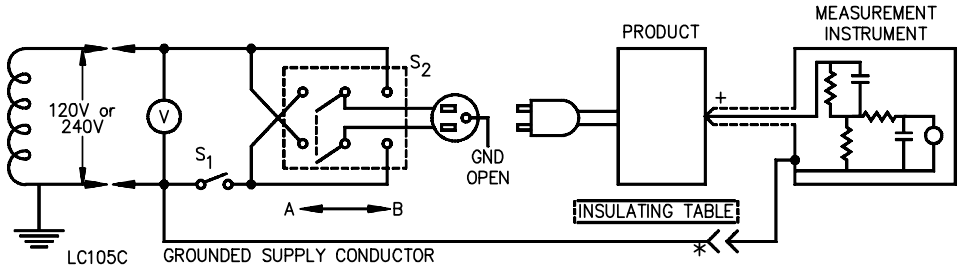
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of the voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response – ratio of indicated to actual value of current – equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15-microfarad capacitor to 1500 ohms. At an indication of 0.5 milliampere, the measurement is not to have an error of more than 5 percent at 60 hertz.

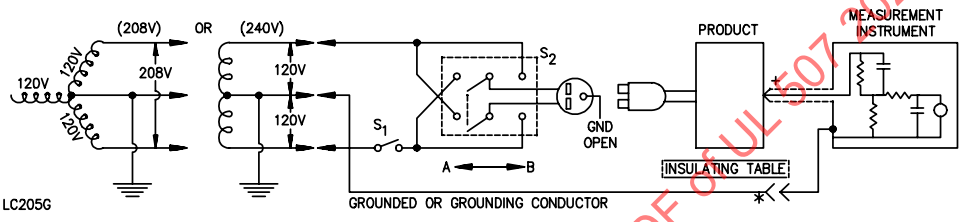
d) Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

Figure 41.1

Leakage current measurement circuits



Product intended for connection to a 120-V or an end-grounded 2-wire 240-volt power supply



Product intended for connection to a 3-wire 208-volt or a 3-wire 240-volt grounded neutral power supply

NOTES:

+ – Probe with shielded lead.

* – Separated and used as a clip when measuring current from one part of appliance to another.

41.6 A sample of the appliance is to be tested for leakage current in the as-received condition, without prior energization except as occurs as part of the production line testing, but with the grounding conductor open at the attachment plug. The supply voltage is to be adjusted to the values specified in 46.1.10. The test sequence, with reference to the measuring circuit, Figure 41.1, is to be as follows:

a) With the switch S1 open, the appliance is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the appliance switching devices in all their normal operating positions.

b) Switch S1 is then to be closed, energizing the appliance, and within 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the appliance switching devices in all their normal operating positions.

c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation as in the normal temperature test.

41.7 Normally the complete leakage current test, as described in 41.6, is to be conducted without interruption for other tests. However, with the concurrence of those concerned, the leakage current test is not prohibited from being interrupted to conduct other nondestructive tests.

42 Continuity of Grounding Circuit Test

42.1 The resistance shall be not more than 0.1 ohm between any point required to be grounded, as specified in 35.1.2, and:

a) For an appliance intended for permanent electrical connection, the point on the enclosure at which the power-supply system is connected.

b) For a cord-connected appliance employing a grounding conductor in the cord, the point to which the grounding conductor of the power-supply cord is connected.

42.2 The resistance shall be determined by any convenient method. When unacceptable results are obtained, either a direct or alternating current equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device that is employed with the appliance is to be passed from the equipment grounding terminal or the point of attachment of the wiring system to the dead metal part, and the resulting drop in potential is to be measured between these two points. The resistance in ohms is determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

43 Limited Short-Circuit Test

43.1 A knockout construction as described in the Exception to 14.2.3 shall maintain its integrity, no melting or otherwise opening of the knockout connection, when subjected to the limited short-circuit test described in 43.2 and 43.3.

43.2 Three samples of the enclosure/conduit construction are to be subjected to the test. The current is to be as specified in Table 43.1. The test circuit is to have a power factor of 0.9 – 1.0 and is to be limited to the current specified in Table 43.1. The open-circuit voltage of the test circuit is to be 100 – 105 percent of the rated voltage of the equipment.

Table 43.1
Circuit capacity for short circuit test

Nominal voltage	Equipment full load amperes, single phase				Circuit capacity, amperes
	120	208	240	277	
	0 – 9.8	0 – 5.4	0 – 4.9	–	200
	9.9 – 16	5.5 – 8.8	5.0 – 8.0	0 – 6.5	1000

43.3 The enclosure is to be connected to the circuit through appropriately sized 6 inch-length of flexible metal conduit and a ground terminal suitable for connection of 3/0 AWG copper conductors is to be installed as close as possible to the internal conduit locknut. The free ends of each 4 foot-length of 3/0 AWG copper conductor are connected to each the supply as described in 43.2 through a series connected nonrenewable fuse that does not open in less than 12 seconds when carrying twice its rated current.

44 Starting Current Test

44.1 When operated as described in 44.3, an appliance shall start and operate normally without:

a) Tripping an overload protector provided as part of the appliance; or

b) Opening the fuse, when connected to a circuit protected by a fuse as described in 44.2.

44.2 The fuse mentioned in 44.1(b) is to be other than a time-delay type. The current rating of the fuse is to be equal to the current rating of the supply circuit of the lowest rating to which the appliance is intended to be connected.

Exception: A time-delay fuse shall not be employed, unless the appliance is marked in accordance with 80.1.3 and:

a) The construction of the appliance or the nature of its usage is such that it is used continually on the same branch circuit after installation – for example, a window fan, an attic ventilator, or the like; or

b) The appliance is of the household type that is used on a 15- or 20- ampere branch circuit.

44.3 To determine whether an appliance complies with the requirements in 44.1, the appliance is to be connected to a power-supply circuit protected by a fuse as specified in 44.2 or in the exception to 44.2, whichever applies. The appliance is to be at room temperature at the beginning of the test. The appliance is to be started three times without tripping an overload protector provided as part of the appliance, or opening the fuse protecting the supply circuit. Each start of the appliance is to be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle in the case of an automatic appliance. The motor of the appliance is to be allowed to come to full speed after each start, and to come to rest between successive starts.

44.4 An appliance employing a general use receptacle shall be loaded to the marked rating of the receptacle outlet. See 21.19.

45 Input Test

45.1 The current input to an appliance shall be not more than 110 percent of the rated value when the appliance is operated under conditions of intended service, when connected to a power-supply circuit at the test voltage shown in Table 40.1 and rated frequency.

46 Temperature Test

46.1 All fans

46.1.1 When tested as described in 46.1.3 – 46.2.2, an appliance shall not:

a) Attain constant temperatures at any point on the fan sufficiently high to result in a risk of fire;

b) Cause deterioration of any materials employed in the appliance; or

c) Have constant temperature rises at specific points (particularly those surfaces that may be contacted by the user with the fan operating as intended) more than those specified in Table 46.1. (See 46.1.12.)

Table 46.1
Maximum temperatures

Materials and components	C (Degrees)	F (Degrees)
ALL FANS		
1. Varnished-cloth insulation	85	185
2. Fuses	90	194
3. Fiber employed as electrical insulation	90	194
4. Wood and other combustible material	90	194
5. Any point on or within a terminal box of a permanently-wired appliance	90[g]	194[g]
6. A surface upon which a stationary appliance may be mounted in service, and surfaces that may be adjacent to the appliance when so mounted	90	194
7. Class A insulation systems on coil windings		
Thermocouple method	105	221
Resistance method	115	239
8. Class B insulation systems on coil windings		
Thermocouple method	125	257
Resistance method	135	275
9. Class E system on coil windings		
Thermocouple method	115	239
Resistance method	125	257
10. Class F system on coil windings		
Thermocouple method	150	302
Resistance method	160	320
11. Class H system on coil windings		
Thermocouple method	165	329
Resistance method	175	347
12. Phenolic composition employed as electrical insulation or as a part of the deterioration of which would result in a risk of fire, electric shock, or injury to persons	150[b]	302[b]
13. Rubber or thermoplastic-insulated wires and cords	60[b,c,d]	140[b,c,d]
14. Capacitors		
Electrolytic	65[e]	149[e]

Table 46.1 Continued on Next Page

Table 46.1 Continued

Materials and components	C (Degrees)	F (Degrees)
Other types	90[f]	194[f]
15. Sealing compound	40°K (72°R) less than melting point	
16. Class 105 insulation systems on windings of a relay, a solenoid, and the like		
Thermocouple method	90	194
Resistance method	105	221
17. Class 130 insulation systems on windings of a relay, a solenoid, and the like		
Thermocouple method	110	230
Resistance method	130	266
18. Lampholder screw shell, center contact, or other connecting device of aluminum or unplated copper	200	392
19. Lampholder body of thermosetting material (phenolic, urea, and the like)	150	302
CEILING INSERT FAN/LIGHT COMBINATIONS		
20. Points of fixture support	90	194
21. Screen, shield, or recessed housing in contact with insulation	90	194
SURFACES SUBJECT TO CONTACT		
22. Handles or knobs that are grasped for lifting, carrying, or holding:		
Metallic	50	122
Non-metallic	60	140
23. Handles or knobs that may be contacted but do not involve lifting, carrying, or holding when heated; and other surfaces that may be contacted during intended operation[i, l]:		
Metallic	60	140
Non-metallic	85	185

[b] The temperature limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to a compound that has been investigated and found to have acceptable heat-resistance properties.

[c] Rubber-insulated conductors within a Class A insulated motor and rubber-insulated motor leads, and a rubber-insulated flexible cord entering a motor may be subjected to a temperature of more than 60°C (140°F), provided that an acceptable braid is employed on the conductors of other than a flexible cord. This does not apply to thermoplastic-insulated wires or cords.

[d] A short length of rubber or thermoplastic-insulated flexible cord exposed to a temperature of more than 60°C (140°F), such as at terminals, is acceptable when supplementary heat-resistance insulation of acceptable dielectric strength is employed on the individual conductors of the cord to reduce the risk of deterioration of the conductor insulation, and when the strain-relief means does not depend upon that portion of the insulation subjected to the excessive temperature.

[e] For an electrolytic capacitor that is integral with or attached to a motor, the temperature on insulating material integral with the capacitor enclosure shall not be more than 90°C (194°F).

[f] A capacitor that operates at a temperature of more than 90°C (194°F) may be judged on the basis of its marked temperature limit.

[g] When the temperature is greater than 60°C (140°F), the fan shall be marked in accordance with 80.7.1 – 80.7.3.

[i] This does not apply to the motor of a pedestal fan on which either no switches are mounted or on which no switches other than pull- chain type are mounted. Also see footnote l.

[l] Accessible motor surfaces of industrial air circulators of the pedestal, wall, or I-beam type employing a user-operated actuator, may exceed the indicated rises if marked in accordance with 81.11.

46.1.2 A thermal protective device shall not operate during the temperature test. See 24.4.

46.1.3 Coil and winding temperatures are to be measured by the change-in-resistance method or by a minimum of four thermocouples located on exposed surfaces of the coil windings, except the change-in-resistance method is to be used for a coil that is inaccessible for mounting of thermocouples, such as a coil:

a) Immersed in sealing compound;

b) Wrapped with thermal insulation; or

c) Wrapped with more than two layers of material such as cotton, paper, or rayon having a total thickness of more than 0.8 mm (1/32 inch).

Exception: The requirement for a minimum of four thermocouples does not apply where physical size does not allow it.

46.1.4 Thermocouples are to consist of wires not larger than 24 AWG. When thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is common practice to employ thermocouples consisting of 30 AWG iron and constantan wires and a potentiometer-type indicating instrument; and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

46.1.5 When the change-in-resistance method is used, determination of the temperature rise of a winding is to be calculated by the following formula:

$$\Delta t = \frac{R_2}{R_1}(K + t_1) - (K + t_2)$$

in which:

Δt is the temperature rise in °C;

R_2 is the resistance of the coil in ohms at the end of test;

R_1 is the resistance of the coil in ohms at the beginning of the test;

t_1 is the ambient temperature in degrees C at the beginning of the test;

t_2 is the ambient temperature in degrees C at the end of the test; and

K is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum; values of the constant for other conductors are to be determined.

46.1.6 When necessary, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown.

46.1.7 The temperatures specified in Table 46.1 are based on an assumed ambient temperature of 25°C (77°F). However, tests are to be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

46.1.8 If the temperature test is conducted at an ambient other than 25°C (77°F), an observed temperature is to be corrected as described in 46.1.9.

46.1.9 An observed temperature is to be corrected by addition [if the ambient temperature is lower than 25°C (77°F)] or subtraction (if the ambient temperature is higher than 25°C) of the difference between 25°C and the ambient temperature. If a corrected temperature exceeds the limit specified in Table 46.1, at the request of the manufacturer, the test may be repeated at a temperature closer to the rated operating ambient.

46.1.10 For the temperature test, the test voltage for an appliance is to be as specified in Table 40.1. When the appliance has a single frequency rating, the test is to be conducted at that frequency. An appliance that has more than one frequency rating is to be tested at its minimum and maximum rated frequency, unless it can be established that one test will result in the most severe operating conditions.

46.1.11 The appliance is to be operated under each condition of normal service. For a multispeed appliance, this includes operation at each speed and, for a reversible appliance, it includes operation in each direction of rotation. When a reversible appliance continues to rotate in the same direction, but at a slower speed, when the reversing switch is thrown, the requirement applies at the lower speed as well as at the normal speed. The test is to be continued until temperatures have become constant.

46.1.12 A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minutes, indicate no further increase.

46.1.13 An appliance employing a general use receptacle shall be loaded to the marked rating of the receptacle. The maximum length of the supply cord is to be used for the Temperature Test.

46.1.14 Appliances shall be tested at the appliance's maximum normal load condition. Maximum normal load is considered to be the load that approximates as closely as possible the most severe conditions of normal use. It is not a deliberate overload except as the conditions of actual use are likely to be somewhat more severe than the maximum load conditions that are recommended by the manufacturer of the appliance. An appliance having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements. An appliance intended to normally operate with its intake and/or discharge restricted shall be operated with the air intake and\/or discharge adjusted sufficiently to cause a maximum wattage input to the appliance.

46.1.15 For fans rated 12 Amps or less, and that employ wiring terminals for field wiring connections, the Temperature Test is to be conducted with supply wiring sized for the ampacity of the fan. When the fan is rated more than 12 Amps, the fan is to be tested with supply wiring sized 125 percent of the rating of the fan.

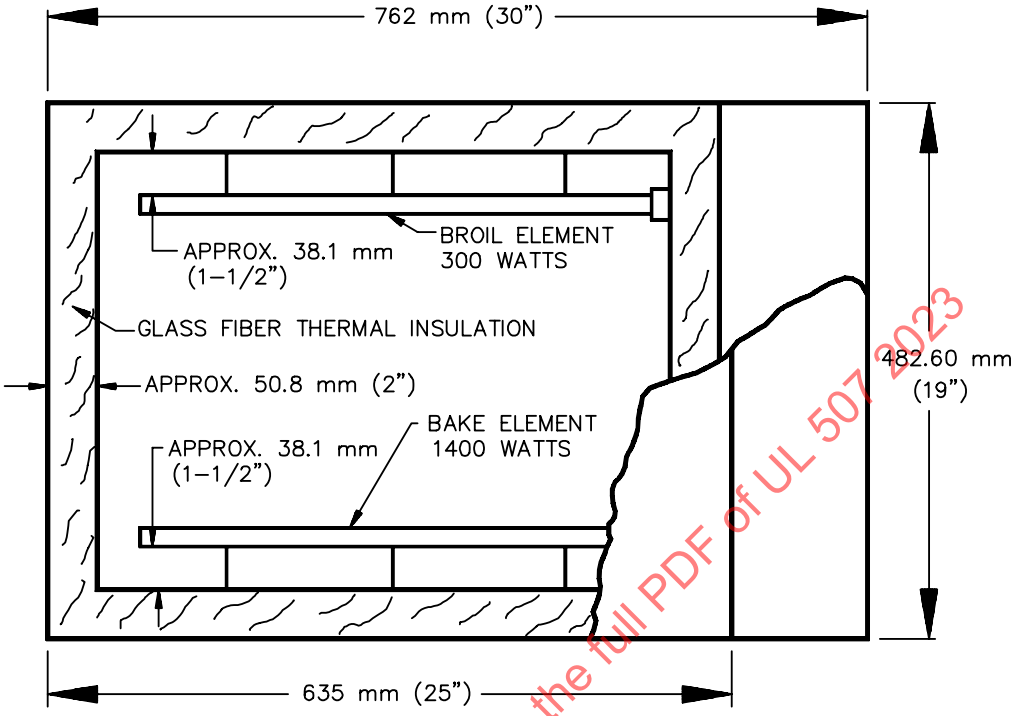
46.2 Fans for use over an eye-level range oven

46.2.1 The temperature test for a fan intended for use over an eye-level range oven is to be conducted with the appliance mounted above a heat source as described in 46.2.2 and illustrated in Figure 46.1, in accordance with the manufacturer's instructions. The test is to be conducted with the appliance and heat source in a 2-sided right side and rear-alcove of 9.525-mm (3/8-inch) thick plywood. The sides of the alcove are to be painted black and are to extend at least 609.6 mm (2 feet) beyond the outermost edges of the assembly. The appliance and heat source are to be as close to the side and back of the alcove as their configuration permits. The test is to be conducted first with the fan on and with only the bake element energized with the thermostat set to give a temperature of 246°C (475°F) with the door of the heat source closed. The test is then repeated with the heat source set for broiling and the door open 101.60 mm (4 inches). Both of these tests are then to be repeated with the fan off.

46.2.2 The heat source illustrated in Figure 46.1 is to be constructed of sheet metal having an average thickness of 0.81 mm (0.032 inch). The thermal insulation is to weigh 16.02 kilograms per cubic meter (1 pound per cubic feet). The heat source is to be approximately 381 mm (15 inches) deep, front to back, including the 25.4-mm (1-inch) thick door. The door is to be hinged on the left side and may be closed or opened as much as 101.60 mm (4 inches). The elements are to consist of coiled resistance wire embedded in fused magnesium oxide completely enclosed in nickel-alloy stainless steel. The heat from the source is to be controlled with a thermostat in which the bulb and capillary tube are located at the top of the heat source, toward the side.

Figure 46.1

Heat source for temperature tests of fans for use over an eye-level range oven

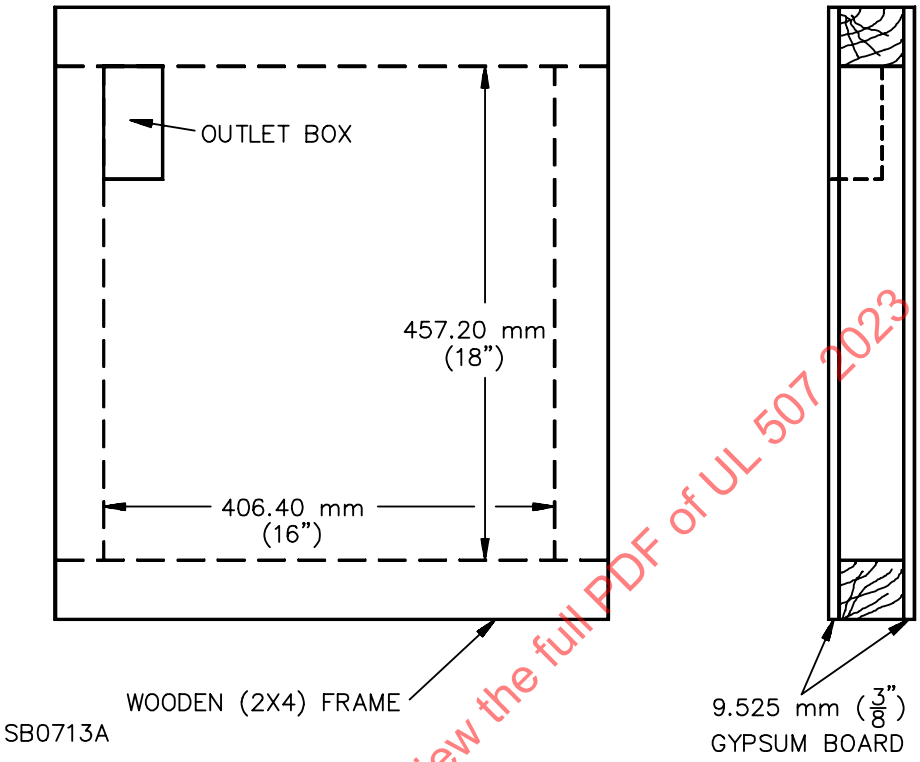


46.3 Controllers

46.3.1 For the temperature test, a separate controller – that is, a controller that is not a physical part of the appliance – that is intended for installation in a wall is to be mounted as follows. The controller is to be secured inside its own enclosure, if provided. Otherwise, it is to be installed inside the smallest standard flush-type outlet box that accommodates it, and the box is to be mounted in a simulated wall section as illustrated in Figure 46.2.

Figure 46.2

Method of mounting outlet box



47 Dielectric Voltage Withstand Test

47.1 An appliance shall withstand for 1 minute without electrical breakdown the application of a DC potential or an AC potential at a frequency within the range of 40 to 70 Hz between the following:

a) Uninsulated live metal parts and the enclosure. A non-conductive enclosure is to be wrapped in conductive foil.

b) Terminals of opposite polarity.

c) Uninsulated live metal parts and accessible dead metal parts.

d) Uninsulated live metal parts and grounding contacts of grounding type receptacles.

e) Primary and isolated secondary circuits.

47.2 The test potential shall be as shown in Table 47.1.

Table 47.1
Dielectric voltage withstand voltages

Machine voltage rating, V	Test potential V AC	Test potential V DC
Appliances operating at 50 V or less	500	700
Appliances employing a motor rated 373 W (1/2 hp output) or less and rated 250 V or less	1000	1400
An appliance employing a motor rated more than 373 W (1/2 hp output) or more than 250 V	1000 + 2V[a]	1400 + 2.8V[a]
[a] Maximum marked voltage.		

47.3 Capacitors connected across-the-line or line-to-ground shall withstand a DC dielectric potential of 1414 volts plus 2.828 times the maximum rated supply voltage, without breakdown for 1 minute, between the terminals of the capacitor, and between the terminals and foil wrapped around the case of the capacitor. The test shall be conducted with the capacitor at normal operating temperature.

47.4 To determine whether an appliance complies with the requirements in 47.1, it is to be tested using a 500-volt-ampere or larger capacity transformer, the output voltage of which can be varied. The applied potential is to be increased from zero to the required test value and is to be held at that level for 1 minute. The increase in applied potential is to be at a substantially uniform rate as rapid as is consistent with correct indication of its value by a voltmeter.

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

47.5 The test equipment for conducting the dielectric voltage-withstand test is to be adjusted for sensitivity such that when a resistor of 120,000 ohms is connected across the output, the test equipment does not indicate unacceptable performance for any output voltage less than the specified test voltage, and the test equipment does indicate unacceptable performance for any output voltage equal to or greater than the specified test value. The resistance of the calibrating resistor is to be adjusted as close to 120,000 ohms as instrument accuracy can provide, and not more than 120,000 ohms.

Exception No. 1: The sensitivity of the test equipment shall not be reduced, and a lower value of calibrating resistance shall not be used, unless testing an appliance intended to be permanently wired.

Exception No. 2: The sensitivity of the test equipment shall not be increased, and a higher value of calibrating resistance shall not be used, unless agreeable to those concerned.

47.6 An appliance employing a reversible shaded-pole motor shall withstand for 1 minute the application of a 60-hertz essentially sinusoidal potential:

a) Between the stator winding and the shading coils; or

b) Between the shading coils and the stator core, with the appliance at the temperature reached in intended use.

The value of the test potential is to be as specified in 47.2.

48 Water Spray Test

48.1 General

48.1.1 The following appliances shall comply with the applicable water spray test requirements as specified in this section:

a) Any appliance intended for installation in a window opening;

b) A roof ventilator;

c) An attic fan;

Exception: When an attic fan has instructions that comply with 83.8, the fan is not required to be subjected to the tests described in this section.

d) A wall-insert fan, other than a wall-insert fan intended for use over a bathtub or shower and tested in accordance with Section 181, Performance;

Exception: When a wall-insert fan is intended for commercial or industrial use and is marked in accordance with 80.5.3 and 80.5.5, or when the fan is intended for mounting in an interior wall only and complies with 80.5.4, the fan is not required to be subjected to the tests described in this section.

e) An in-wall fan;

f) Any appliance that is intended for outdoor use or in any location that includes direct contact with water or rain;

g) A nonresidential cord-connected fan that is not marked in accordance with 81.5 and that is not intended to be fastened in place;

h) A dryer type fan;

Exception: When a dryer type fan, intended for indoor use only, already complies with 195.1, the water spray test is not required.

i) A damp location fan for use in cooking areas; and

j) A box fan.

Exception: When it is obvious from the construction or installation that an appliance would exclude the water spray, the water spray test is not required to be conducted.

48.1.2 Compliance with the water spray test shall be determined by:

a) A visual inspection to determine that there is no wetting of uninsulated live parts or film-coated wire – other than motor windings – and no accumulation of water in the wiring compartment or channel. The accumulation of water droplets shall only be acceptable when the fan complies with the tests in (b) and (c). A drain hole may be provided to reduce the accumulation of water above a level that results in the wetting of an electrical part or wiring compartment.

Exception: The visual inspection shall include the check of motor windings to verify that there is no wetting if the Exception of 22.6 is applied.

b) A leakage current test for 120 volt cord connected appliances (see 48.4.1 – 48.4.6) or an insulation resistance test for all other appliances (see 48.5.1).

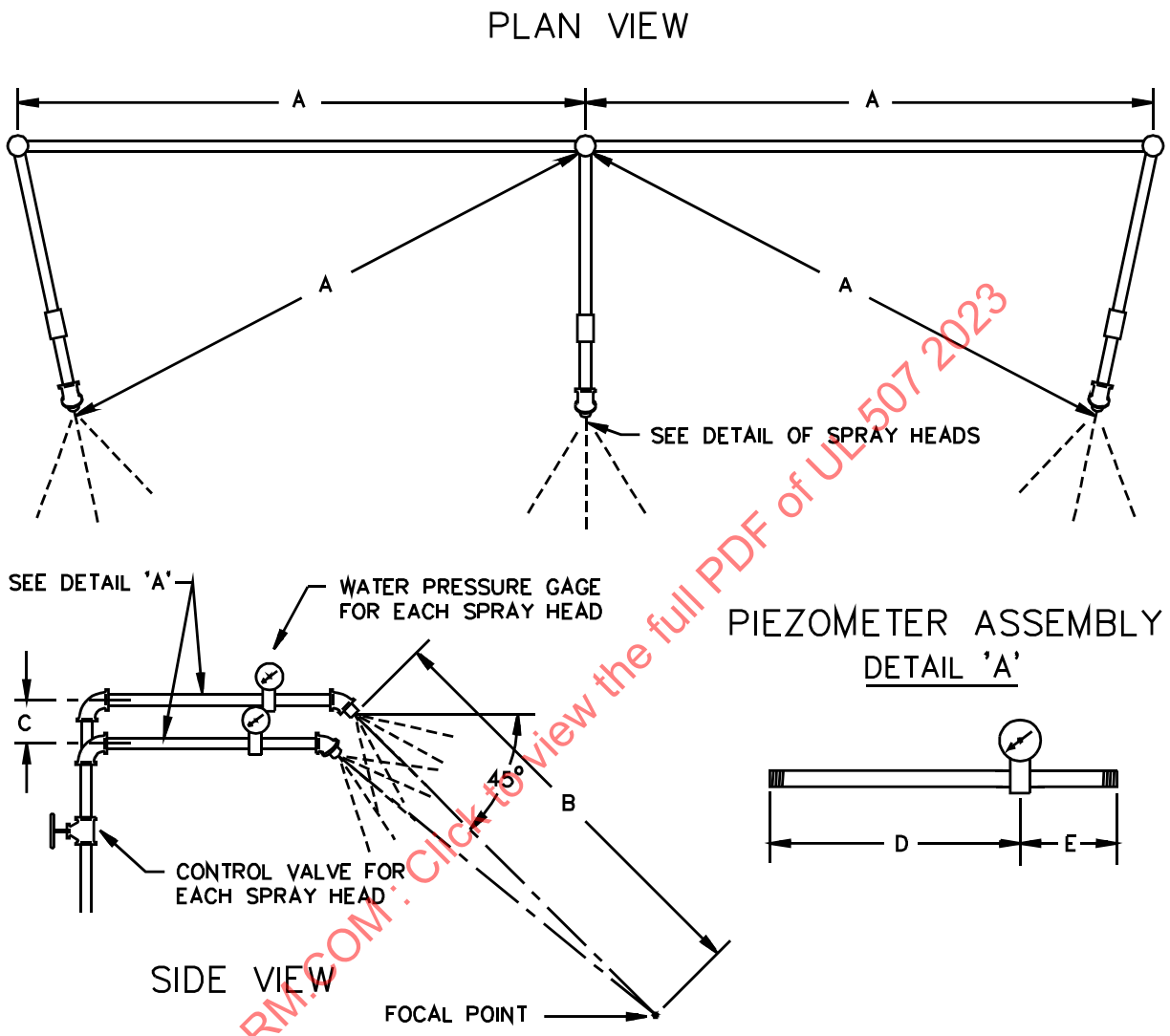
c) A dielectric voltage withstand test (see 48.6.1).

48.2 Test preparation

48.2.1 The water spray test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 48.1. Spray heads are to be constructed in accordance with the details shown in Figure 48.2. The water pressure for all tests is to be maintained at 34.48 kPa (5 psi) at each spray head. The appliance shall be positioned in the focal area of the spray heads of the rain test apparatus so that the greatest quantity of water is likely to enter the enclosure of the appliance. The spray is to be vertical toward the louvers or other openings nearest current-carrying parts.

Figure 48.1

Spray head pipe rack

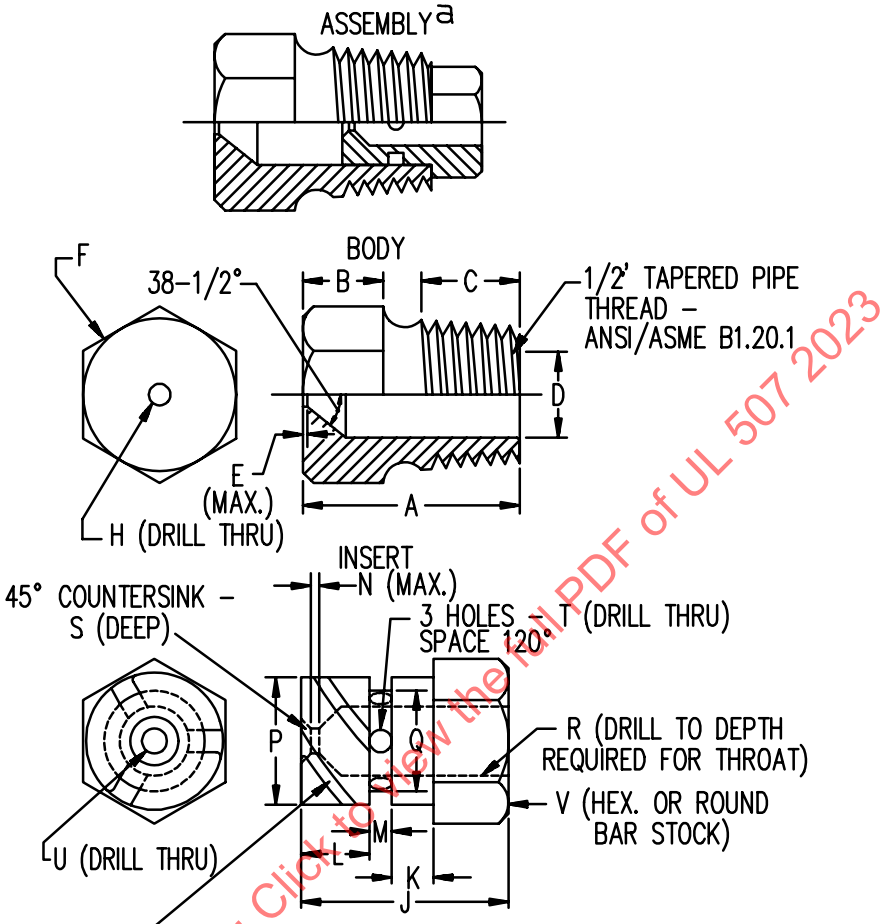


Item	mm	inch
A	710	28
B	1400	55
C	55	2–1/4
D	230	9
E	75	3

RT101F

Figure 48.2

Spray head assembly



Item	mm	inch	Item	mm	inch
A	31.0	1–7/32	N	0.80	1/32
B	11.0	7/16	P	14.61	.575
C	14.0	9/16		14.63	.576
D	14.68	.578	Q	11.51	.453
	14.73	.580		11.53	.454
E	0.40	1/64	R	6.35	1/4
F	c	c	S	0.80	1/32
G	1.52	.06	T	2.80	(No. 35) [b]
H	5.0	(No.9) [b]	U	2.50	(No. 40) [b]
J	18.3	23/32	V	16.0	5/8
K	3.97	5/32	W	1.52	0.06
L	6.35	1/4			
M	2.38	3/32			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

RT100F

48.3 Procedure

48.3.1 The appliance is to be mounted in accordance with the installation instructions. For items of installation not covered by the instructions, the most severe method of test installation is to be used.

48.3.2 The appliance is to operate during the exposure when it:

a) Is intended to draw air in rather than expel it; or

b) Has louvers that open only when the appliance is operating.

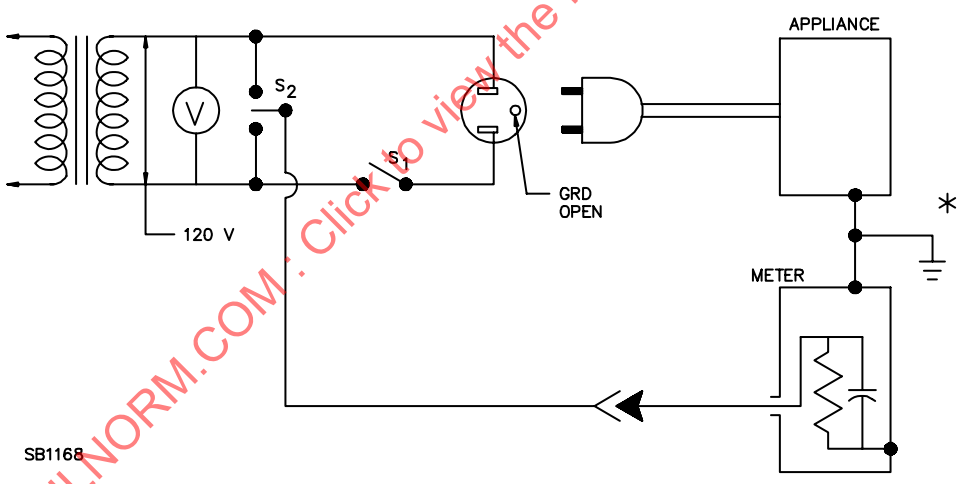
Other appliances are not to operate during the water spray.

48.3.3 The appliance is to be subjected to a water spray for 4 hours in the direction most likely to cause water to enter.

48.3.4 Before conducting a leakage current measurement with the circuit in Figure 48.3, the appliance is to be disconnected from the receptacle. It is to be determined by closing S1, utilizing both positions of S2, and observing the leakage currents at the meter, that the stray leakage currents are negligible.

Figure 48.3

Leakage current measurement circuit for the water spray test



48.4 120 volt cord-connected appliances

48.4.1 The water spray test is to be conducted with the switch in the "on" position. For a multispeed appliance, the "on" position of the switch is to be the low-speed setting.

48.4.2 The leakage current is to be measured using the test methods and equipment described in 41.2 – 41.5, except that the circuit shown in Figure 48.3 is to be used. The leakage current is to be measured with switches S1 and S2 in all possible positions.

48.4.3 During exposure to the water spray described in 48.2.1, the leakage current is to be monitored using both positions of S2. The leakage current shall be no more than 2.5 milliamperes.

48.4.4 Immediately upon cessation of the water spray, the appliance is to be turned off by opening switch S1 unless it was in the open position during the exposure to the water. The leakage current shall be no more than 2.5 milliamperes.

48.4.5 After the 30-minute monitoring period, the leakage current is to be measured with switch S1 open and using both positions of switch S2. The leakage current shall be no more than 0.5 milliampere.

48.4.6 Immediately after each of the leakage current measurements, a dielectric voltage withstand test is to be conducted as described in 48.6.1.

48.5 Other than 120 volt cord connected appliances

48.5.1 Immediately after the water spray test, the insulation resistance measured between live parts and interconnected dead metal parts of an appliance shall be 50,000 ohms or more. After the insulation resistance measurement, the appliance shall comply with the dielectric voltage withstand test described in 48.6.1.

48.6 All appliances

48.6.1 Within 1 minute of cessation of the water spray and also 30 minutes after cessation of the water spray, a dielectric voltage withstand test shall be conducted in accordance with Section 47, Dielectric Voltage Withstand Test, except that the duration of the applied potential is to be 15 seconds for the test conducted within 1 minute of cessation of the water spray test.

49 Hosedown Test

49.1 When required by 80.1.9, the hosedown test shall be conducted on a fan.

49.2 At the conclusion of the test described in 49.3 – 49.5, a fan shall have no standing water inside the enclosure and there shall be no water on uninsulated live parts or on film-coated wire, other than motor windings.

49.3 For a permanently installed fan that is connected to conduit during installation, a conduit is to be installed on the enclosure to equalize internal and external pressures as required, but it is not to serve as a drain. No sealing compound other than that normally provided by the manufacturer is to be used. The enclosure interior is to be dry.

49.4 The enclosure and its external mechanisms are then to be sprayed by water from a hose having a 25.4-mm (1-inch) inside diameter nozzle that delivers at least 246 L (65 gallons) of water per minute. The water stream is to be directed at the fan from a distance of 3 – 3.7 m (10 – 12 feet) and is to be moved along the enclosure or surface at a minimum rate of 1.6 cm/sec (4 inches per second).

49.5 For an enclosure having a test length – height plus width plus depth dimension – of 1.9 m (75 inches) or less, the duration of the water stream contact with the enclosure is to be 5 minutes. For an enclosure having a test length exceeding 1.9 m (75 inches), the duration of water stream contact in minutes is to be 2.6 times the test length measured in meters (the test length measured in inches divided by 15).

50 Locked Rotor Test

50.1 An impedance-protected motor used in a wall-insert fan, ceiling-insert fan, a fan intended for use in cooking areas, or a fan in which the motor is subjected to conditions such as restricted ventilation or proximity to an external source of heat, shall comply with the requirements in 50.5 and 50.6.

50.2 For fans rated 12 Amps or less, and that employ wiring terminals for field wiring connections, the Locked Rotor Test is to be conducted with supply wiring sized for the ampacity of the fan. When the fan is rated more than 12 Amps, the fan is to be tested with supply wiring sized 125 percent of the rating of the fan.

50.3 The fan is to be installed or placed in its intended position with the rotor of the fan motor locked and energized as described in the Locked-Rotor or No-Load Temperature Test in the Standard for Impedance Protected Motors, UL 1004-2. The temperature is to be determined after thermal equilibrium is attained.

50.4 In determining compliance with the requirements specified in 50.3, motor temperature readings are to be taken as follows:

a) The temperature is to be measured by means of thermocouples applied directly to the actual conductor material or the integrally applied conductor insulation. Thermocouples shall be placed under the coil wrap, when provided; or

b) The temperature is to be measured by use of the change-in-resistance method.

c) In the instance where the motor is totally enclosed and the temperature can not be determined by the method in either 50.4 (a) or (b), the temperature is to be measured by thermocouples placed on the enclosure.

50.5 Under locked-rotor conditions:

a) The stabilized temperature of an impedance-protected motor shall not exceed the temperature obtained when the motor was tested in the open in accordance with the Locked Rotor or No-Load Temperature Test in the Standard for Impedance Protected Motors, UL 1004-2; or

b) The motor shall comply with the requirements in 50.6.

50.6 When the stabilized temperature of the impedance-protected motor installed in the fan exceeds the temperature of the motor tested in the open in accordance with the Standard for Impedance Protected Motors, UL 1004-2, or if the motor was never so tested, the rotor is to remain locked for 18 days under the conditions specified for the Locked-Rotor or No-Load Temperature Test in UL 1004-2, except the motor is to be installed in the fan as specified in 50.3. During the initial 72 hours, the motor temperature shall not exceed the applicable temperature limits specified in UL 1004-2. During and after the 18-day period, the motor shall comply with the Locked-Rotor or No-Load Temperature Test requirements in UL 1004-2.

50.7 Under locked rotor conditions, the temperature of a thermally protected motor shall not exceed the requirements in the Standard for Thermally Protected Motors, UL 1004-3.

51 Locked Rotor Cycling

51.1 Three motor samples are to be provided with the coil wrap terminating on the bend of the coil and are to be subjected to the test described in 51.2 – 51.4.

51.2 Each sample is to be energized at a test potential in accordance with Table 40.1 with the rotor locked. The motor circuit is to be cycled on and off as quickly as the motor allows. The winding temperatures shall reach the maximum temperature and the minimum temperature shown in Table 51.1, as determined with a thermocouple. The test duration is to be for 18 days with the motor at room temperature at the beginning of the test.

51.3 Protective devices shall be by-passed and when the motor does not function throughout the test, a different motor shall be chosen and the test started from the beginning. When a part, such as a capacitor, can be replaced in order for the motor to function, then the test may continue.

51.4 As a result of the test in 51.2 and 51.3, there shall be no loosening of the coil wrap, lifting of the coil wrap termination greater than 1.6 mm (1/16 inch), nor other degradation of the coil wrap's adhesive bond as determined by visual examination.

Table 51.1
Locked rotor cycling temperature limits

Insulation class	Maximum temperature		Minimum temperature	
	°C	(°F)	°C	(°F)
A	175	(347)	125	(257)
E	190	(374)	140	(284)
B	200	(392)	150	(302)
F	225	(437)	175	(347)
H	250	(482)	200	(392)

52 Flagging

52.1 The test method for flagging shall be in accordance with the Test for Flagging (as received), Method A-For Class 1 Tape, of the Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D 1000-04.

52.2 The rod used for the test shall be 19 mm (3/4 inch) in diameter.

52.3 The length of the unwound tape (flag) from the end of the tape to the point of tangent of the rod shall be less than 1.6 mm (1/16 inch).

53 Humidity Conditioning Test

53.1 A sample of the appliance is to be heated to a temperature just above 34°C (93°F) to reduce the likelihood of condensation of moisture during conditioning. The heated sample is then to be placed in the humidity chamber and conditioned for 48 hours in air having a relative humidity of 88 ±2 percent and a temperature of 32 ±2°C (90 ±4°F). Following the conditioning:

a) A cord-connected appliance rated for a nominal 240-volt supply or less is to be tested in the unenergized condition as specified in 41.6(a). The sample is then to be energized and tested as specified in 41.6 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases. The leakage current shall not be more than the applicable value in 41.1.

b) An appliance other than as mentioned in (a) is to have an insulation resistance of 50,000 ohms or more between live parts and exposed dead metal parts.

c) An appliance shall comply with the dielectric voltage withstand requirements in 47.1.

53.2 Insulation resistance is to be measured by means of a high-resistance voltmeter using a 250-volt, direct-current circuit.

54 Strain Relief Test

54.1 The strain relief means provided on a flexible cord shall withstand for 1 minute without displacement a direct pull of 155.68 N (35 pounds) applied to the cord with the connections within the appliance disconnected. The strain relief is not acceptable when, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress on the connections has resulted.

Exception: The strain relief means provided in a through cord switch shall be in accordance with the requirements of 54.4.

54.2 The strain relief means provided on a flexible cord shall withstand for 1 minute without displacement a torque as shown in Table 42.1 in either direction between the cord and the enclosure with the connections within the appliance disconnected. The strain relief is not acceptable when, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress on the connections has resulted.

Exception: The strain relief means provided in a through-cord switch shall be in accordance with the requirement in 54.4.

Table 54.1
Torque requirements

Weight of appliance, W kg (pounds)	Torque N·m
W < 1.0 (2.2)	0.10
1.0 (2.2) ≤ W ≤ 4.0 (8.8)	0.25
W > 4.0 (8.8)	0.35

54.3 A 16-kg (35-pound) weight is to be suspended from the cord and supported by the appliance so that the strain-relief means can be stressed from any angle the construction of the appliance permits.

54.4 The strain relief means provided in a through cord switch shall withstand for 1 minute a direct pull of 133.44 N (30 pounds). The strain relief is not acceptable when a conductor is detached from a terminal or an uninsulated conductor of the cord is exposed.

54.5 For the construction mentioned in 15.2.3, six samples of the clamp that have been secured to the cord in the intended manner are to be used. Three samples are to be subjected to the dielectric voltage withstand test specified in Section 47, Dielectric Voltage Withstand Test, and shall then comply with the strain-relief test specified in 54.1 in the as-received condition. Three samples shall comply with the requirements specified in 54.1 after being subjected to the following procedures:

a) The samples are to be placed for 168 hours in a forced-draft air-circulating oven maintained at a temperature of 70°C (158°F) or 10°C (50°F) higher than the temperature recorded on the clamp during the Temperature Test, Section 46, whichever is greater.

b) The samples are then to be subjected to the dielectric voltage withstand test specified in Section 47, Dielectric Voltage Withstand Test, with the value of the applied potential based on the rating of the appliance. The potential is to be applied between conductors, and the potential is also to be applied between the clamp and all conductors spliced together.

c) The conditioned samples then are to be cooled at room temperature.

55 Interconnecting Cords and Leads

55.1 Each lead or flexible cord provided for wiring between components or for interconnection between parts of a motor, (e.g. motor windings to capacitor, motor connections to receptacle, light connections to receptacle, etc.) shall be subjected to the test described in 54.1 and 54.3 except that the pull shall be 20 pounds (89 N). Each lead or cord is to be tested with the 20-pound (9-kg) weight.

Exception No. 1: This test is to be waived if the lead or cord is routed such that it cannot be easily grasped or subject to other means of mechanical strain.

Exception No. 2: This test is to be conducted on all leads simultaneously when the leads are bundled such that individual leads cannot be easily grasped or subject to other means of mechanical strain.

Exception No. 3: When testing the terminals of a device intended for crimp connection, there shall be no damage to the connection or separation of the conductor from the crimp.

Exception No. 4: Mechanically secured and soldered connections and the connections of multi-pole connectors are not required to be disconnected prior to application of the force.

56 Unguarded Impeller Tests

56.1 An impeller of a portable fan not required to be guarded shall not break, crack, or chip when operated for 1 hour connected to a supply voltage of 130 percent of the rated supply voltage. The test is to be conducted before and after conditioning as described in 56.2.

56.2 An impeller not required to be guarded is to be placed in an air-circulating oven maintained at 70°C (158°F) for 7 hours. After removal, it is to be tested as described in Section 56, Unguarded Impeller Tests; Section 61, Impact Test on Guards; and Section 70, Drop Test. As a result of the testing, the impeller shall not break.

56.3 A motor-driven impeller not required to be guarded shall be energy absorbent to the extent that a 3.2 mm (1/8 inch) diameter dry hardwood dowel does not break when thrust into a rotating blade. The fan is to be fixed in place and energized so that the impeller rotates at intended speed. The dowel is to be supported on a stable, stationary flat surface perpendicular to the plane of rotation. The surface is to have a straight edge located approximately 9.5 mm (3/8 inch) from the fan blade. The dowel is then to be suddenly thrust and retained by hand along an axis perpendicular to the plane of impeller rotation into the blade. This procedure is to be repeated at different points on the impeller (blade and hub) with the impeller rotating at all intended speeds and from in front of and behind the impeller in order to include the most severe condition.

57 Push Back Relief Test

57.1 With reference to 15.2.4, a cord-connected fan shall be tested in accordance with 57.2 without occurrence of any of the following conditions:

a) Mechanical damage to the supply cord or lead;

b) Exposure of the supply cord or lead to a temperature higher than that for which it is rated;

c) Reduction of spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damage to internal connections or components.

57.2 The supply cord or lead is to be held 25 mm (1 inch) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. When a removable bushing which extends further than 25 mm (1 inch) is present, it is to be removed prior to the test. When the bushing is an integral part of the cord, the test is to be carried out by holding the bushing. The cord or lead is to be pushed back into the product in 25-mm (1-inch) increments until the cord buckles or the force to push the cord into the product exceeds 27 N (6 pounds-force). The supply cord or lead within the product is to be manipulated to determine compliance with 57.1.

58 Oscillating Fan Test

58.1 An oscillating or adjustable appliance in which normal function causes movement of the power supply cord, electrical wiring or other insulated live parts, shall withstand an endurance test for the number of cycles described in 58.2. Upon completion of the test:

a) There shall be no electrical malfunction of the appliance;

b) There shall be no exposure of an uninsulated conductor strand either within or outside of the enclosure;

c) The appliance shall comply with the Dielectric Voltage Withstand Test;

d) There shall be no breakage of more than 10 percent of the strands of any conductor strands; and

e) There shall be no signs of oscillation cord or wire insulation abrasion.

58.2 The endurance test required by 58.1 is to consist of:

a) 750,000 cycles of operation for an appliance in which the movement of the power-supply cord, electrical wiring, or other insulated live parts occurs as a result of the operation of an automatic mechanical feature.

b) 6000 cycles of operation for an appliance in which the movement of the power-supply cord, electrical wiring or other insulated live parts only as a result of the operation of a manual feature.

Exception: The 6000 cycle test in 58.2 need not be conducted if it is determined that the component power supply cord has been previously subjected to the 6000 cycle flex testing, and it is determined in the application that it is not subjected to rubbing, chafing, or similar mechanical stress.

58.3 Where movement of electrical wiring or other insulated live parts occurs, six representative samples shall be subjected to this test. Throughout the test, the appliance shall be continuously energized at maximum rated input. The movable member shall be operated so that it will reach the limits of travel in both directions during each cycle by either the integral automatic mechanical feature of the appliance or by a external mechanical arrangement that operates the movable member. The cycling rate shall be one of the following:

a) Twelve cycles per minute;

b) The rate at which the automatic mechanical feature operates, if the rate is less than 12 cycles per minute; or

c) Greater than 12 cycles per minute using the external mechanical arrangement, if agreeable to all concerned, or as controlled by the integral automatic mechanical feature.

58.4 For an oscillating fan with a tilting head assembly, two samples are to be oriented in the head fully forward position, two are to be oriented in the head straight up position, and two are to be oriented in the head fully back position.

59 Tests of Switches and Controls

59.1 Overload

59.1.1 A switch or other device that controls a motor and that has not been previously investigated for its suitability of controlling a motor shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. As a result of the test, there shall be no electrical or mechanical breakdown of the device. The fuse in the grounding connection shall not open.

Exception: This requirement does not apply to a switch or other device interlocked so that it does not have to break the locked-rotor current of the motor.

59.1.2 In a test to determine whether a switch or other control device complies with the requirements in 59.1.1, the appliance is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage in accordance with 46.1.10, with the rotor of the motor locked in position. During the test, exposed dead metal parts of the appliance are to be connected to ground through a 3 ampere plug fuse, and the connection is to be such that any single-pole, current-rupturing device is connected in the ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, or on direct current as well as on alternating current, the exposed dead metal parts are to be connected so as to be positive with respect to a single-pole, current-rupturing control device. The device is to be operated at a maximum rate of 10 cycles per minute, except that a faster rate of operation is to be employed only when agreeable to all concerned.

59.2 Reversing

59.2.1 A motor-reversing switch shall withstand a test consisting of 1000 cycles of operation as described in 59.2.2. There shall be no electrical or mechanical breakdown of the switch, nor pitting or burning of the contacts that impairs intended operation.

Exception: This requirement does not apply to a reversing switch that reverses the direction of rotation by changing the connections between shading coils that are insulated from the main windings.

59.2.2 To determine whether a switch complies with the requirements in 59.2.1, the appliance is to be connected to a circuit of maximum rated voltage. Each cycle of operation is to consist of throwing the switch to the position in which the fan blades rotate in one direction, allowing the blades to come to full operating speed in that direction, then – without pause in any intermediate "off" position unless the switch does not function otherwise – throwing the switch to the position in which the rotation of the blades is reversed, allowing the rotation to attain normal operating speed in that direction, and then reversing the direction of rotation again by throwing the switch to the initial "on" position.

60 Static Load Test For Mounting Means

60.1 When subjected to the test specified in 60.2 – 60.3, a cord-connected wall- or ceiling-surface mounted or direct plug-in appliance shall comply with the following:

a) The security of the attachment of the appliance to the wall shall not be adversely affected;

b) There shall be no evidence of a risk of fire or electric shock;

c) The insulation resistance between live and dead-metal parts shall not be less than 50,000 ohms; and

d) The appliance shall withstand for 1 minute without breakdown the application of a 60-hertz essentially sinusoidal potential of 1000 volts between live and dead-metal parts.

Exception: This requirement does not apply to cord-connected rangehoods.

60.2 An appliance that is wall or ceiling surface mounted as mentioned in 60.1 is to be mounted in accordance with the installation instructions provided by the manufacturer on 3/8-inch-thick plasterboard (dry wall) on nominal 2 by 4-inch wood studs/joists spaced on 24 inch (609 mm) centers. The mounting parts are to be used as specified in the instructions, and the securing screws are to be located between the studs/joists and secured in the plasterboard.

Exception: Commercial/industrial products shall be mounted in accordance with the installation instructions provided by the manufacturer.

60.3 After installation, the appliance is to be subjected to a static load. The load is to be applied so as to transmit the maximum amount of stress to the mounting means and is to be increased during a 5 to 10 second interval, until a load equal to the weight of the product plus a force of three times the weight of the product, but not less than 10 pounds (45 N), is applied to the mounting system. The load is to be maintained for 1 minute.

60.4 Testing is to be repeated for all industrial/commercial air circulator fan head/mounting assembly combinations as described in 80.4.2.

60.5 For a Ceiling Insert Fan with tab type mounting means, the Static Load Test is subjected to the applicable requirements in 60.1 – 60.3, except for the modifications specified in (a) through (d):

a) The security of the attachment of the appliance to the ceiling shall not be adversely affected;

b) The face of the product secured by the tab mounting means shall not permanently displaced more than 1/8 in (3.2 mm) from its original position. The displacement shall be measured 1 minutes after the test load has been removed.

c) During the installation, the tab mounting means are to be used and set up in accordance with the instructions; and

d) The load is to be maintained for 5 minutes.

61 Impact Test on Guards

61.1 A guard which is subject to impact, such as one on a portable fan, a window fan, a floor insert fan, a crawl space fan, or a wall insert fan installed less than 7 feet above the floor, the malfunction of which results in a risk of injury to persons, that is subjected to impact shall withstand the impact test described in 61.2 and 61.3 in the as-received condition.

61.2 In lieu of conducting the room temperature test described in 61.2 and 61.3, equipment intended to be used in cold environments, such as outdoor use products or fans mounted in a crawl space, shall be cooled to a temperature of minus 35.0 ±2.0°C (minus 31.0 ±3.6°F) for outdoor use products and 0°C (32°F) for crawl space or attic mount products and maintained at this temperature for 3 hours. While the appliance is still cold, the specimens shall be subjected to the impact described in 61.2 and 61.3. The conditions for acceptable results are indicated in 61.4 – 61.6.

Exception: This requirement does not apply to portable fans marked for use in outdoor applications.

61.3 An appliance is to be subjected to an impact of 6.67 N (1.5 foot-pounds) on any surface that is exposed to a blow during intended use. Only one impact is to be applied at a given point. The impact is to be produced by dropping a steel sphere, 50.8 mm (2 inches) in diameter and weighing approximately 0.54 kg (1.18 pounds), from a height of 381 mm (15 inches). For surfaces other than the top of an enclosure, the steel sphere is to be suspended by a cord and allowed to swing as a pendulum, dropping through a vertical distance of 381 mm. For the test on a freestanding fan, the fan is to stand in its intended operating position without restraint.

61.4 Following the impact test, the probe illustrated in Figure 9.1 is to be used to determine whether a portion of an impeller that presents a risk of injury to persons is exposed.

61.5 Deformation of a guard or detachment of a guard or portion of a guard during the impact test is acceptable if the part can readily be restored to its original shape or replaced in the intended manner. After restoration of the guard, the probe illustrated in Figure 9.1 shall not contact a portion of an impeller that can cause risk of injury to persons when inserted in any opening of the guard.

61.6 When the guard also serves as an enclosure, the guard shall be subjected to the impact test specified in 9.1.3.

61.7 With reference to 61.5, cracking or denting of the enclosure shall not affect the function of any safety controls or constructional features such as thermostats, overload protective devices, waterseals, or strain relief.

62 Static Force Test on Guards

62.1 When a 88.96-N (20-pound) force is applied for 1 minute over a 50.8-mm (2-inch) diameter area to any part of the guard of a portable fan or window fan, spacings to a moving part that presents a risk of injury to persons shall not be permanently reduced to the degree that the probe shown in Figure 9.1 contacts a portion of the moving part when inserted in any opening in the guard.

Exception: When the 88.96-N force tips over a freestanding fan, the force to be employed is the value that gives the maximum deflection without tipover. The test is to be conducted with and without the fan operating and with any adjustments made to provide the greatest resistance to tipping.

63 Impeller Test for Portable Fans

63.1 With reference to the requirement in 9.2.12, the following tests are to be conducted on non-metallic impellers of portable fans and window fans. A 6.35 mm (1/4 inch) diameter steel rod is to be pushed suddenly into the blade with the fan resting on the floor and operating at maximum speed and rated voltage. A test is to be made with the rod inserted near the hub, and a second sample is to be tested with the rod inserted 2/3 of the distance from the hub to the tip of the blade. The rod is to rest on the guard as it is inserted. A part of the blade is not to be thrown more than 1.52 m (5 feet) from the closest part of the base of the fan.

Exception: When an opening is smaller than 6.35 mm (1/4 inch), use the largest standard diameter steel rod that physically fits.

64 Impeller Ignition Test

64.1 The requirements in this Section are intended to investigate the risk of fire for fans as referenced in the Exception No. 1 (e) of7.4.2.

64.2 A polymeric impeller that is located outside a thermally protected motor on a fan that does not comply with 7.4.2 and Exception No. 1 (a) – (d) of 7.4.2 the shall not ignite as a result of a locked rotor test conducted as described in 64.3.

Exception: When the impeller ignites, the results meet the intent of the requirement only when the cheesecloth does not ignite and there is no emission of flame beyond the fan enclosure during the following test on three additional fans:

a) A double layer of cheesecloth is to completely cover each fan before the test; and

b) The test described in 64.3 is to be repeated.

64.3 The motor thermal protector is to be shunted out of the motor winding so that the motor stays continually energized. The rotor is to be locked. The fan is to be positioned as intended in application and is to be energized in a room ambient temperature of 10 to 40°C (50 to 104°F) at the voltage indicated in Table 40.1. The fan is to be energized until ultimate results are observed, but no more than 18 days. This procedure is to be repeated on two additional fan samples.

64.4 The cheesecloth referenced in the Exception to 64.2 is to be bleached, 914.40 mm (36 inches) wide, 28.22 – 30.24 meters per kilogram (14 – 15 yards per pound), and having what is known to the trade as a count of 32 × 28 – that is, along the two directions parallel to the threads, there are 13 threads per centimeter in one direction and 11 threads per centimeter in the other (32 threads per inch in one direction and 28 threads in the other).

65 Component Breakdown Test

65.1 As required by 34.1, a fan shall be subjected to the Component Breakdown Test as specified in 65.2 – 65.12.

65.2 With reference to 65.1, a risk of fire or electric shock is determined to exist when any of the following occur:

a) Glowing, charring, or flaming of the cheesecloth or tissue paper as specified in 65.6;

b) Opening of the 3 Amp fuse specified in 65.7;

c) Emission of flame, sparks, or molten metal from the enclosure;

d) Creation of any openings in the enclosure that results in accessibility of live parts, when judged in accordance with Accessibility of Live Parts, Section 10; and

e) Loss of structural integrity to a degree that the equipment collapses or experiences displacement of parts that leads to short-circuiting or grounding of live parts.

65.3 The circuit between any two terminals of a device is to be opened or shorted. Only one of the simulated fault conditions is to be imposed at a time. For a multi-terminal device, only two terminals are to be short-circuited at a time. Simulated circuits are not prohibited from being used, but when the tests

performed on simulated circuits indicate damage to other parts of the fan to the extent that the safety of the fan is affected, the tests shall be repeated on the fan.

65.4 Each test is to be conducted on a separate sample unless it is agreeable to those concerned that more than one test be conducted on the same sample.

65.5 A part of the fan that is removed during routine operation or maintenance is to be omitted when it results in a more severe test, and the part is not:

a) Required for the functioning of the equipment; and

b) Exposed to view during intended operation.

Exception: The part is not required to be removed during testing when it can only be removed by the use of a tool.

65.6 During these tests, the sample is to be placed on a softwood surface covered with white tissue paper, and a single layer of cheesecloth is to be draped loosely over the entire enclosure.

Exception No. 1: Fans not having bottom openings are not required to be placed on a softwood surface covered with white tissue paper.

Exception No. 2: When it is impractical to drape the entire enclosure, cheesecloth is to be placed only over all ventilating openings.

65.7 During each test, exposed dead-metal parts of the sample are to be connected to earth ground through a 3 Amp nontime-delay fuse.

65.8 The supply circuit is to have branch circuit overcurrent protection, the size of which equals 125 percent of the input current rating (20-ampere minimum). When this value does not correspond with the standard rating of a fuse or a circuit breaker, the next higher standard device rating shall be used. The test voltage and frequency are to be adjusted to the maximum rated voltage of the fan.

Exception: When a marking on the fan or the manufacturer's literature indicates the use of branch circuit protection exceeding 125 percent of the input current, such protection shall be used.

65.9 A fuse that is replaced during routine maintenance is to be defeated unless marked in accordance with 81.8. A fuse that is soldered in place, or is located such that it is accessible only to qualified service personnel, and marked in accordance with 81.8, and any other overcurrent protective device not subject to replacement during routine maintenance is to be left in the circuit.

65.10 Each abnormal condition is to be conducted for 7 hours or until one or more of the following results are observed:

a) A risk of fire or electric shock develops (see 65.2);

b) The branch-circuit fuse opens;

c) The supplementary protective device opens;

d) A minimum of one hour elapses, circuit conditions stabilize, and there is no further evidence of overheating of parts.

65.11 The overheating of parts referred to in 65.10(d) is to be detected by an indicator such as an odor, smoke, discoloration, cracking of materials, charring, flaming, glowing, arcing, changes in circuit current through the applied fault, or any similar phenomenon.

65.12 When a fault condition is terminated by the opening of a circuit component, the test is to be conducted two more times using new components for each test.

66 Fuseholder Cover Test

66.1 When required by 25.3, an open cover shall be subjected to a force of 36 N (8 lbs) applied for 1 minute in any direction that the cover may be removed, the open cover of a fuseholder, fused attachment plug, or current tap, or similar device, shall not detach from the body of the device. One fuseholder is to be tested.

67 General Purpose Transformers

67.1 General

67.1.1 In addition to the end-product Temperature Test and Dielectric Voltage-Withstand Test, a general purpose transformer shall also be subjected to the tests of 67.2 – 67.4.

67.2 Voltage measurement test

67.2.1 For purposes of comparison with voltages measured as described in the Overload Test of 67.3, each secondary open-circuit voltage shall be measured with the primary connected to a test voltage and frequency supply source as indicated in Input Test, Section 45.

67.3 Overload test

67.3.1 A transformer shall be subjected to the test conditions described in 67.3.2. The stabilized surface or core temperature recorded on the transformer during the second 50 percent load operation shall not be more than 5°C (9°F) greater than the stabilized core temperature obtained during the initial 50-percent of load operation. The open-circuit output voltage determined following the final 50 percent load operation shall be within 2 percent of the output voltage measured during the Voltage Measurement Test in 67.2. As an option, a protective device, if provided, may be bypassed when conducting this test.

67.3.2 The transformer shall be operated as described in the Temperature Test in Section 46, except that the load shall be 50 percent of the rated value, until the core, or surface temperatures if encapsulated, stabilize. After stabilization, the load shall be adjusted until 200 percent of rated secondary current is reached. After 2 minutes of operation, the load shall be readjusted, if necessary, to restore the current to 200 percent, but no further adjustment is to be made thereafter. The duration of this overload shall be 30 minutes. The load is then to be restored to the original 50 percent of rated value. It shall be held at that value until the core temperature again stabilizes or until the temperature drops to within 5°C (9°F) of the original stabilized 50-percent load-current temperature (whichever occurs first). This temperature value shall be compared with the original 50-percent load stabilized condition, as specified in 67.3.1. Then, the secondary load shall be removed. With the primary energized, the secondary voltage(s) shall be measured and compared with the original output voltage measurements.

67.3.3 When the core of the transformer is not accessible for direct temperature measurement (due to the transformer construction or reasons such as encapsulation or filling with electrical insulating material), the surface of the transformer enclosure shall be used. The portion of the enclosure surface used to measure this temperature shall be the hottest spot occurring in the 100-percent load heating test.

67.3.4 A protective device, when provided, shall be bypassed when the device opens while the load is adjusted after the surface temperatures have stabilized.

67.4 Repeated dielectric voltage-withstand test

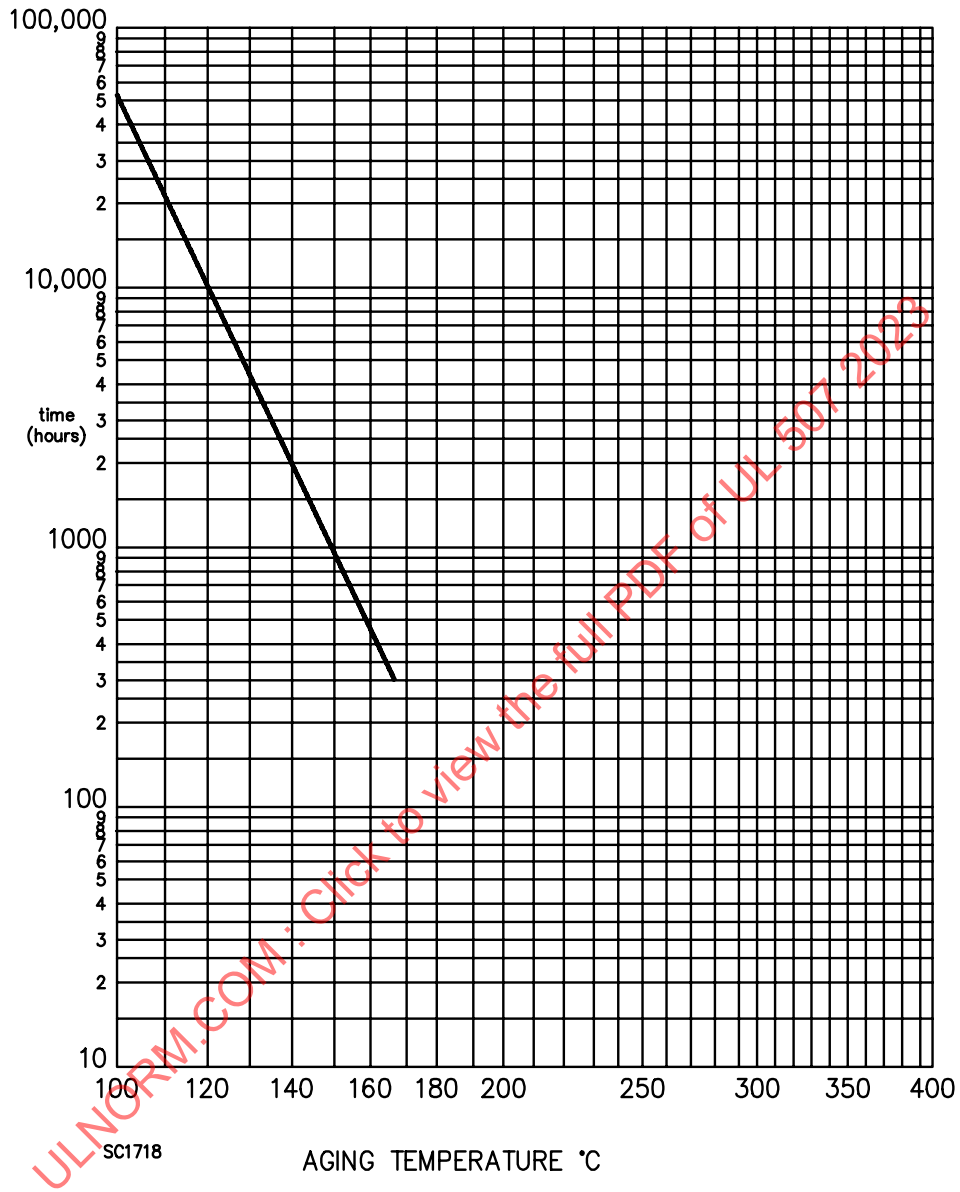
67.4.1 Following the Overload Test in 67.3, the transformer shall be subjected to a repeated dielectric voltage-withstand test. The test potential shall be 65 percent of the value originally specified. After this test, the transformer shall perform as intended.

68 Thermal Aging

68.1 A polymeric material employed in a Class 105 (A) insulation system in accordance with the Exception to 33.3 is to be aged for the amount of time corresponding to an aging temperature that appears on the Class 105 (A) system response shown in Figure 68.1. The insulation system is to cool to room temperature and the applicable dielectric voltage-withstand requirements specified in Section 47 are to be applied between live parts and noncurrent-carrying metal parts that are isolated from each other by the material under consideration.

Figure 68.1

Class 105 (A) system response



69 Permanence of Marking Tests

69.1 In addition to complying with 80.1, General, and, after being tested as described in 69.2 and 69.3, a tag used for a cautionary marking in accordance with 80.8.1 is considered to be permanently affixed to a power-supply cord if there is no:

a) Tearing at any point for more than 1/16 in (1.6 mm),

b) Separation from the power-supply cord,

c) Shrinkage, deformation, cracking, or other condition that will render the marking on the tag illegible,

d) Torn or otherwise damaged overlamination. The printing shall remain legible and the overlamination shall remain in place, or

e) Slippage or movement along the length of the cord set more than 1/2 inch (13 mm) and there shall not be any visible damage to the cord.

69.2 To determine compliance with 69.1, a cord tag shall be conditioned in accordance with (a) – (c). Following the conditioning each sample shall be tested in accordance with 69.3. If a tag is applied by an adhesive, the conditioning and test are to be conducted no sooner than 25 h after application of the tag.

a) Three samples, as received, shall be tested in accordance with 69.3.

b) Three samples shall be conditioned in an air-circulating oven at 60 ±1°C (140 ±1.8°F) for 240 h followed by 30 min of conditioning at a room temperature of 23 ±2°C (73.4 ±3.6°F) and 50 ±5% relative humidity then followed by the test in 69.3.

c) Three samples shall be conditioned for 72 hr at a humidity of 85 ±5% at 32 ±2°C (89.6 ±3.6°F) and followed by test in 69.3 within 1 min after conditioning.

69.3 Each sample is to consist of a length of power-supply cord to which the tag has been applied. The power-supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 lbf (22.2 N) is to be applied for one minute to the upper-most corner of the tag farthest from the power-supply cord, within 1/4 in (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. In determining compliance with 69.1 (d), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 69.1 (d), each sample is to be scraped 10 times across printed areas and edges, with a force of approximately 2 lbf (8.9 N), using the edge of a 5/64-in (2.0-mm) thick steel blade held at a right angle to the test surface.

PERFORMANCE – PORTABLE APPLIANCES

70 Drop Test

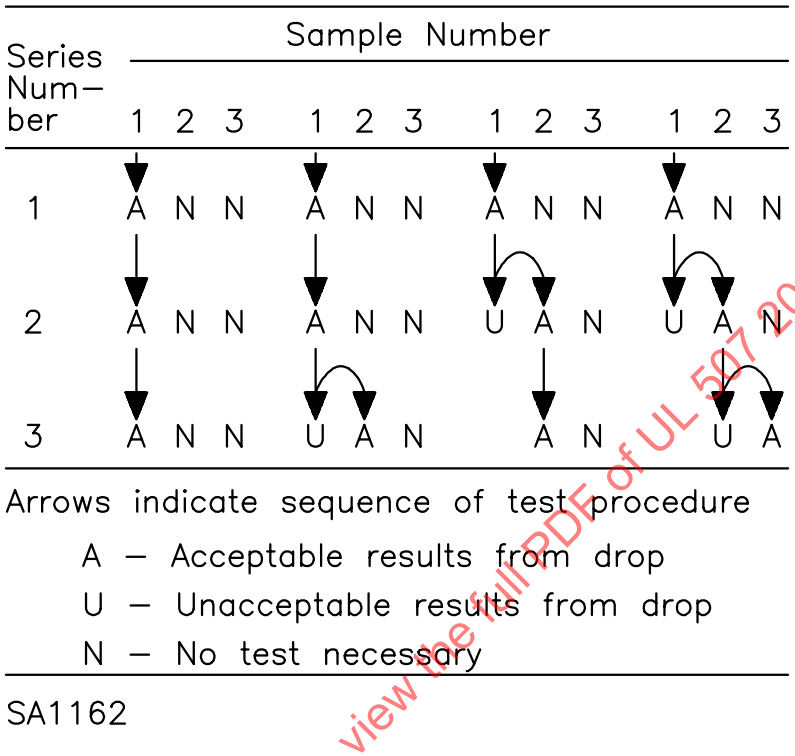
70.1 A desk fan and a box fan shall withstand, with the fan operating at maximum speed, the drop test described in 70.2.

70.2 Each of three samples of a fan is to be dropped through a distance of 914.40 mm (3 feet) to strike a hardwood surface. Each sample is to be dropped three times. Three samples shall be employed for the test; however, if the manufacturer so elects, fewer samples may be used in accordance with Figure 70.1. As a result of the drop test, the probe illustrated in Figure 9.1 shall not be able to contact a portion of a blade or blower wheel that presents a risk of injury to persons when inserted in any opening in the guard.

Figure 70.1

Procedure for drop tests

Each series consists of three drops on each sample as applicable



70.3 The hardwood surface mentioned in 70.2 is to consist of a layer of 19-mm (3/4-inch) thick tongue-and-groove oak flooring mounted on two layers of 19-mm (3/4-inch) thick plywood. The assembly is to rest on a concrete floor during the test.

70.4 All samples are to be supported on a surface 914.40 mm (3 feet) above the hardwood surface. Each sample is to be dislodged from the supporting surface by a sudden pull applied to the power-supply cord in a plane parallel to the supporting surface and twice by being pushed by a force parallel to the mounting surface applied to the top of the sample, which is to be placed at the edge of the supporting surface. The sample is to be oriented differently for each test.

70.5 Deformation of a guard or detachment of a guard or portion of a guard during the drop test is acceptable when the part (including ribs of a desk fan) can readily be restored to its original shape or a detached guard can be readily replaced in the intended manner. After restoration of the guard, the probe illustrated in Figure 9.1 shall not contact a portion of a blade or blower wheel that presents a risk of injury to persons when inserted in any opening in the guard.

70.6 A part of the blade shall not be thrown more than 1.52 m (5 feet) from the closest part of the base of the fan.

71 Security of Handle Test

71.1 A handle used to support or carry a fan shall withstand a force of four times the weight of the fan without breakage of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

71.2 To determine if a handle complies with the requirements in 71.1, the force is to be started at zero and gradually increased so that the force specified in 71.1 is attained in 5 to 10 seconds and maintained for 1 minute. When the handle is 76.20 mm (3 inches) or more in width, the force is to be uniformly distributed over a 76.20-mm width at the center of the handle without clamping. When the width is less than 76.20 mm, the force is to be distributed over the entire handle. When more than one handle is furnished on a fan and the fan cannot be carried by only one handle, the force is to be distributed between the handles. The distribution of forces is to be determined by measuring the percentage of the fan weight sustained by each handle with the fan in the intended carrying position. When a fan is furnished with more than one handle and can be carried by only one handle, each handle is to sustain the total force.

72 Stability Test

72.1 A cord-connected freestanding appliance shall not tip over when placed on a plane inclined 10 degrees from the horizontal.

72.2 In addition to the requirement in 72.1, a pedestal intended for ceiling fan mounting that is 1.68 m (66 inches) high or more and that also weighs 11.34 kg (25 pounds) or more shall not tip over when placed as intended on a horizontal surface and subjected to a force of 44.48 N (10 pounds) applied horizontally at a point farthest from the horizontal surface up to a maximum of 1.52 m (5 feet).

72.3 In addition to the requirements in 72.1, a cord connected freestanding appliance that is 2.1 m (6.9 ft) high or more shall not tip over when placed as intended on a horizontal surface and subjected to a force of 20 pounds applied horizontally at a height of 1.6 m (62 inches).

72.4 During the tests described in 72.1, 72.2, and 72.3, the appliance is to be prevented from sliding along the supporting surface and is to be adjusted and operated in any intended manner so that it is most likely to tip over. The test procedure is to include such items as:

a) Positioning or removal of casters or feet that do not require a tool for removal;

b) Operating the fan at maximum speed and then evaluating it in the "off" position;

c) Adjusting the fan into any intended position; and

d) Fixing an oscillating type fan at any point in the oscillating cycle of movement.

72.5 Testing is to be repeated for all industrial/commercial air circulator fan head/stand assembly combinations as described in 80.4.2. Consideration shall be given to any factor contributing to product stability including: stand height, front/back head rotation, side/side head oscillation, diameter of head assembly, and size/weight of motor assembly.

73 Hassock Fan Load Test

73.1 A hassock fan shall sustain a 1779 N (400 pound) load uniformly distributed over the top of the fan for 1 minute, without breakage or cracking of the enclosure or guard, after which the probe illustrated in Figure 9.1 shall not contact a portion of the impeller that presents a risk of injury to persons when inserted through any opening in the guard or enclosure.

PERFORMANCE – PERMANENTLY CONNECTED APPLIANCES

74 Installation Test

74.1 An appliance intended for permanent connection to a power supply shall be subjected to an installation test in which the appliance is assembled and installed in accordance with the manufacturer's

instructions. The appliance shall function in the intended manner and shall comply with the applicable requirements in Sections 40 – 65.

75 Tests for Fans for Unattended Areas

75.1 A fan for use in unattended areas shall comply with the tests described in Sections 178 and 179A.

MANUFACTURING AND PRODUCTION TESTS

76 Dielectric Voltage Withstand Test

76.1 Each appliance shall withstand without electrical breakdown, the application of a AC or DC potential as indicated in Table 76.1 as follows:

a) Between the primary wiring, including connected components, and accessible dead metal parts that are capable of becoming energized; and

b) Between primary wiring and accessible low-voltage (42.4 volts peak or less) metal parts, including terminals.

Exception No. 1: This requirement does not apply to an appliance that has no electrical components other than a motor that is acceptable for permanent connection to the supply source and complies with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

Exception No. 2: For component fans with accessible dead metal, the potential is to be applied between the input leads or terminals and dead metal parts. For component fans with no accessible dead metal, the dielectric voltage withstand test is not required.

76.2 This test shall be conducted in accordance with either condition A or condition B of Table 76.1.

76.3 The appliance is to be in either a heated or unheated condition for the test.

76.4 The test is to be conducted when the appliance is fully assembled. It is not intended that the appliance 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, is not required to be in place.

Exception No. 2: The test shall not be performed before final assembly unless the test represents a test on the completed appliance.

Exception No. 3: An appliance employing a solid-state component that is not relied upon to reduce the risk of electric shock and that is damaged by the dielectric potential may be tested before the component is electrically connected provided that a random sampling of each day's production is tested at the potential specified in Table 76.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state component damage while retaining representative dielectric stress of the circuit.

Table 76.1
Production-line test conditions

Machine voltage rating, V	Condition A			Condition B		
	Test potential V AC (40-70 Hz)	Test potential V DC	Time, seconds	Test potential V AC (40-70 Hz)	Test potential V DC	Time, seconds
60 volts or less	500	700	60	600	850	1
250 volts or less with a motor rated 373 watts (1/2 hp) or less	1000	1400	60	1200	1700	1
250 volts or less with a motor rated more than 373 watts (1/2 hp)	1000 +2V[a]	1400 +2V[a]	60	1200 +2.4V[a]	1700 +3.4V[a]	1
251 – 600 volts	1000 +2V[b]	1400 +2V[b]	60	1200 +2.4V[b]	1700 +3.4V[b]	1

[a] Maximum marked voltage but not less than 120 volts if the maximum marked voltage is within the range 105 – 120 volts, and not less than 240 volts if the maximum marked voltage is within the range 210 – 240 volts.

[b] Maximum marked voltage.

76.5 The test equipment is to include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visible 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.

76.6 When 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.

76.7 When the output of the test equipment transformer is 500 volt-amperes or larger, the test potential shall be indicated by any of the following:

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

76.8 Test equipment other than that described in 76.5 – 76.7 shall be used only when found acceptable to accomplish the intended factory control.

76.9 During the test, the primary switch is to be in the "on" position, both sides of the primary circuit of the appliance 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.

Exception No. 1: A product (resistive, high-impedance windings, or the like) having circuitry not subject to excessive secondary-voltage buildup in case of electrical breakdown during the test may be tested:

a) With a single-pole primary switch in the "off" position; or

b) With only one side of the primary circuit connected to the test equipment when the primary switch is in the "on" position or when a primary switch is not used.

Exception No. 2: The primary switch is not required to be in the "on" position if the test means applies full test potential between primary wiring and dead metal parts with the switch not in the "on" position.

77 Grounding Continuity Test

77.1 Each appliance that has a power-supply cord having a grounding conductor shall be tested to determine the grounding continuity between the grounding blade of the attachment plug and the accessible dead metal parts of the appliance that are capable of becoming energized.

Exception: This requirement does not apply to an unassembled fan kit employing a 3-conductor cord.

77.2 Only a single test is required to be conducted when the accessible metal selected is conductively connected by design to all other accessible metal.

77.3 Any indicating device, such as an ohmmeter, a battery and buzzer combination, or the like, is to be used to determine compliance with the grounding-continuity requirement in 77.1.

78 Polarization Test

78.1 As a routine production-line test, each appliance provided with a manually operated, line-connected, single-pole switch for appliance "on-off" operation; an Edison-base lampholder or an Edison-base fuseholder; or a receptacle shall be tested for electrical continuity between the grounded supply circuit conductor of the attachment plug (wide blade of 2-wire plug) and the part of the appliance that is intended to be connected to the grounded supply circuit conductor of the attachment plug. The polarity shall be determined either visually or through the use of an electrical test. Equivalently, polarity may be verified between the ungrounded supply circuit conductor of the attachment plug and the part of the appliance that is intended to be connected to the ungrounded conductor.

78.2 Any indicating device, such as an ohmmeter, a battery and buzzer combination, or the like, is to be used to determine compliance with the requirement in 78.1.

RATING

79 Details

79.1 An appliance shall be rated in volts and, when intended for use on an alternating current supply, the frequency shall be expressed in one of the following terms: hertz (HZ), cycles-per-second, cps, cycles/second, or c/s.

79.2 An appliance shall also be rated in amperes.

Exception: The appliance may be rated in watts or kilowatts if the overall full-load power factor is 0.80 or more or if the rating of a cord-connected appliance is 50 watts or less.

79.3 When the appliance is intended for connection to a polyphase supply circuit, the electrical rating shall include the number of phases.

79.4 When an appliance is additionally marked with a horsepower rating, the rating shall not be less than the horsepower rating on the motor nameplate. When the appliance consists of multiple motors, or one or more motors and other loads, the rated horsepower, if provided, shall not be less than the equivalent horsepower of the combined loads, calculated in accordance with Section 430-110(C)(1) of the National Electrical Code, ANSI/NFPA 70.

MARKING

80 General Markings

80.1 General

80.1.1 An appliance shall be plainly and permanently marked where visible with:

a) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product is identified – hereinafter referred to as the manufacturer's name;

b) A distinctive catalog number or the equivalent;

c) The electrical rating; and

d) The date or other dating period of manufacture not exceeding any three consecutive months. See 80.1.2.

For a permanently-connected appliance, the marking shall be visible after installation.

80.1.2 With reference to 80.1.1(d), when the date of manufacture is abbreviated or is in a nationally accepted conventional code or in a code affirmed by the manufacturer, the code shall:

a) Not repeat less than 10 years for a household appliance and less than 20 years for a commercial appliance; and

b) Not require reference to the production records of the manufacturer to determine when the appliance was manufactured.

80.1.3 An appliance that does not start and attain normal running speed when connected to a circuit protected by a fuse other than a time-delay fuse as described in 44.1 shall be plainly marked, "If connected to a circuit protected by fuses, use time-delay fuses with this appliance," or with an equivalent wording.

80.1.4 A fan, other than a ceiling insert fan/light combination, provided with a lampholder for an incandescent lamp shall be plainly and permanently marked to indicate the maximum wattage rating of the lamp to be used in the lampholder. The marking shall be legible and located so that it is readily visible after the fan has been installed.

80.1.5 When a manufacturer produces or assembles an appliance at more than one factory, each finished appliance shall have a distinctive marking, such as a code, by which it is identified as the product of a particular factory.

80.1.6 A room-to-room fan shall be marked with the following or equivalent wording: "Do not mount in a fire-rated wall."

80.1.7 Unless known to be acceptable for the application, a pressure-sensitive label that is required to be permanent shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969.

80.1.8 An appliance employing a general use receptacle shall be marked with the rating of the receptacle. See 21.19 and 21.21.

80.1.9 When the fan is marked, or the manufacturer's instructions indicate, that the fan can be hosed down with water, the fan shall be subjected to the test in Section 49, Hosedown Test, and shall comply with the requirements in 166.2, 166.4.4, 166.5.1, 166.7.1, and 169.1.

80.1.10 A fan as described in 15.1.2 or that complies with Exception No. 3 to 14.1.2 or Exception No. 3 to 9.3.2 and/or shipped as described in 80.4.2 shall be marked with the following or equivalent: "Suitable for commercial or industrial use only."

80.1.11 A fan that complies with Exception No. 6 to 14.1.2 shall be marked with the following or equivalent: "This fan shall not be installed behind a suspended floor/ceiling or a structural wall, ceiling, or floor."

80.1.12 An appliance, as described by rows 1 and 2 of Table 15.1, provided with a replaceable in-line fuse or fused attachment plug shall be permanently marked on the device with the following: “Use Only With a Fuse Rated ___ Amperes, ___ Volts.” The blanks shall be filled in with the ampere value consistent with the rating of the fuse or fuses provided. The marking shall be visible during fuse replacement.

80.2 Motors

80.2.1 When an appliance employs a single motor as its only electric-energy-consuming component, the electrical rating given on the motor nameplate is not required to be shown elsewhere on the appliance when the nameplate is readily visible after the motor has been installed in the appliance.

80.2.2 When an appliance employs a dual-voltage motor, and when the motor nameplate provides the electrical rating of the appliance as specified in 80.2.1, the appliance shall be additionally marked – not necessarily in a permanent manner – or other suitable means shall be provided to indicate the voltage for which it is connected when shipped from the factory. When the appliance employs an attachment plug, instructions shall be provided to indicate the type of plug that should be used when the appliance is reconnected for the alternate voltage.

80.2.3 When the motor of a wall-insert fan or ceiling-insert fan is electrically connected to the fan by an attachment plug, both the housing and motor-blade assembly shall be marked with a catalog number, a model designation, or the equivalent regardless of whether the fan is completely assembled when shipped from the factory. Also:

a) The motor-blade assembly shall be marked to positively identify the housing or housings with which it is suitable; or

b) The housing shall be marked to positively identify the motor-blade assembly or assemblies with which it is suitable.

80.2.4 The catalog number or equivalent designation mentioned in 80.1.1, marked on the motor-blade and on the housing, provides adequate marking for compliance with the requirement in 80.2.3. The catalog number or equivalent designation marked on the individual components is considered to comply with the requirement in 80.4.1.

80.2.5 When the motor of an appliance complies with the Exception to 23.1, the appliance shall be marked, "Suitable for Industrial Use Only."

80.2.6 A unit requiring field-provided motor overload protection as required by 26.4 shall have markings readily visible during and after installation stating such, and indicating the motor overload protective devices shall be rated or selected in compliance with the applicable installation code as specified by the authority having jurisdiction.

80.3 Controllers

80.3.1 A separate controller for an appliance, other than a general-use snap switch that is provided in accordance with the requirement in 27.10, shall be marked with:

a) The manufacturer's name; and

b) The catalog number or equivalent designation of the controller unless the marking specifically indicates, by means of the manufacturer's name and by means of a catalog designation or the equivalent, the appliance or appliances with which it is intended to be used.

Unless the intended method of interconnecting the appliance and the controller is obvious, adequate information concerning this interconnection shall be provided by means of a circuit diagram, terminal markings, or the like.

80.4 Shipping

80.4.1 If an appliance is not completely assembled when shipped from the factory, and is shipped from the factory in more than one carton, and if misassembly of components results in a risk of fire, electric shock, or injury to persons (see 11.6 and 11.7):

a) A cross reference marking shall be indicated on each part packaged separately. This marking is not required to be permanent and shall be in the form of a tag or similar temporary marking.

Exception: For small parts shipped in an envelope or other packaging, the marking may be on the package.

b) Each carton containing parts to complete the appliance shall be marked "For Use Only With (Manufacturer's name), Model(s) (Name of Appliance)," or equivalent wording. The carton containing the motor assembly shall be marked "To Complete This (Name of Appliance), Parts Are Shipped In A Separate Carton. Cartons Containing These Parts Are Marked To Indicate Suitability With This Model," or equivalent wording.

80.4.2 Industrial air circulator motor, blade, and grill assemblies shall not be shipped separately from the head assembly. When an industrial/commercial air circulator fan head assembly is shipped separately from stand/mounting assembly:

a) The fan and carton shall be marked with the following, "CAUTION: To Reduce the Risk of Personal Injury, Use Only With Stand/Mounting Assembly Models _____, Manufactured by _____."

b) The stand/mounting assembly and carton shall be marked with the following: "CAUTION: To Reduce the Risk of Personal Injury, Use Only With Fan Head Assembly Model _____, Manufactured by _____."

80.5 Wall- or ceiling-insert fans

80.5.1 A wall- or ceiling-insert fan that has been found to be suitable for use in a cooking area may be marked to indicate that fact. See 112.1.

80.5.2 A wall-insert fan or ceiling-insert fan that is not acceptable for use in a cooking area because the fan does not comply with the requirements in 19.2, 19.3, 113.1.1, 113.2.1, or 116.1 shall be marked legibly with any one of the following, or equivalent wording:

a) "Do not install fan above or inside a 45-degree angle projected outwards from the cooking equipment element closest to the fan. See instruction sheet for clarification;" or

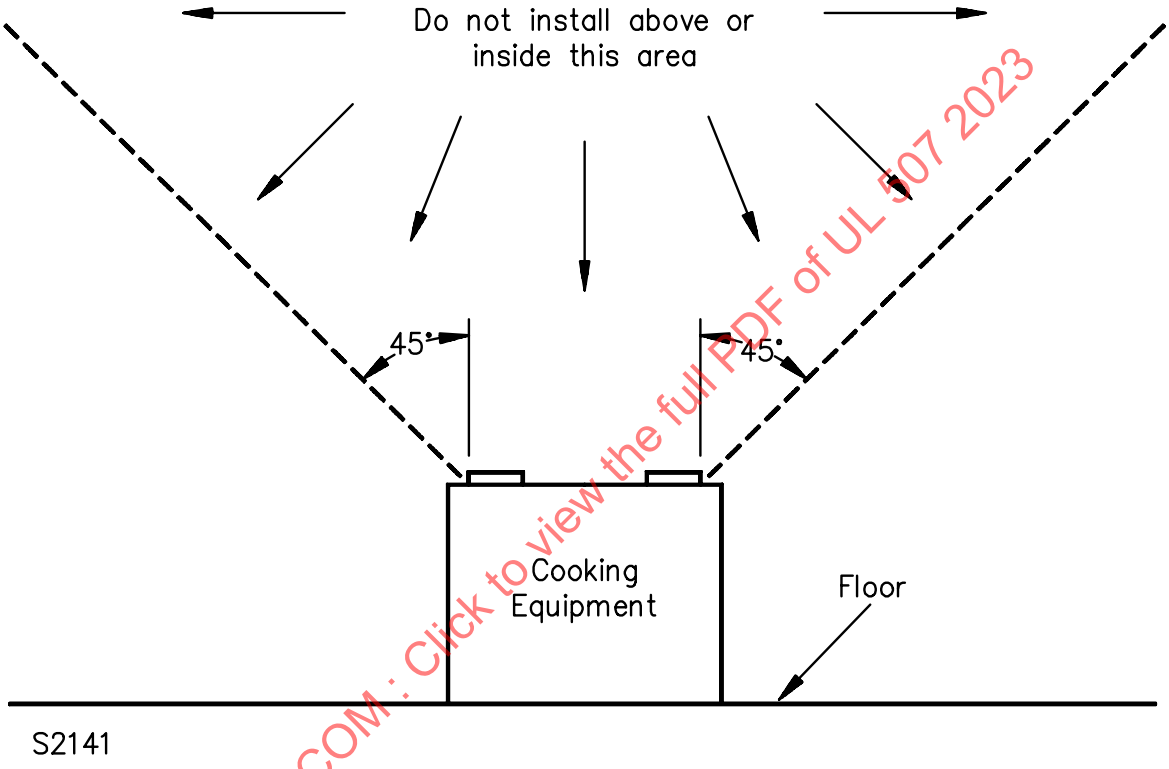
b) "Not for use in cooking area – see installation instructions;" or

c) "Not for Use in Kitchens."

When the wording from (a) or (b) is used, a figure equivalent to that illustrated in Figure 80.1 shall be included in the instruction sheet.

Figure 80.1

Cooking area



80.5.3 Unless equipped with shutters or louvers, or unless it has been found to comply with the requirements in 48.1.1, a wall-insert fan intended for commercial or industrial use – see 48.1.1(d) – shall be marked "Install behind shutters for protection from rain" or with an equivalent wording located so that it will be readily visible after the fan has been installed as intended.

80.5.4 A wall-insert fan intended for mounting in an interior wall shall be permanently marked where the marking is readily visible after the fan has been installed as intended, "Install in interior wall" or with an equivalent wording.

Exception: This marking is not required when it is obvious that the fan is intended to be so mounted.

80.5.5 A wall-insert fan that is intended to comply with the requirements in the Exception to 48.1.1(d) shall be permanently marked in a location visible during installation with the following statement or the equivalent, "For Commercial or Industrial Use."

80.5.6 A fan described in (a) of Exception No. 2 to 9.3.4 shall be marked "Install Fan At Least 1.5 meters (5 Feet) Above The Floor" or with equivalent wording.

80.5.7 A wall or ceiling insert fan or ceiling insert fan/light combination that is provided with a polymeric housing shall be marked, "FOR USE IN NON FIRE RATED INSTALLATIONS ONLY." This marking shall be permanent in letters not less than 2.4 mm (3/32 inch) high, shall be located such that it is visible during installation, and shall be in a contrasting color from the material to which it is applied.

80.5.8 A wall or ceiling insert fan or ceiling insert fan/light combination that is provided with a polymeric housing shall be marked, "FOR USE IN ONE- AND TWO-FAMILY DWELLINGS ONLY." This marking shall be permanent in letters not less than 2.4 mm (3/32 inch) high, shall be located such that it is visible during installation and inspection of wire connections, shall be located near the supply connections, and shall be in a contrasting color from the material to which it is applied.

80.6 Attic-mounted and roof-mounted fans

80.6.1 A fan described in 9.3.6 shall be marked "Install This Side Of The Fan Facing An Unoccupied Space" or with equivalent wording.

Exception: This marking is not required to be provided on the fan when the information is included in the installation instructions.

80.6.2 A fan described in 9.3.7(b) shall be marked "Attach Louvers Or Grilles When Installing The Fan" or with equivalent wording.

Exception: This marking is not required to be provided on the fan when the information is included in the installation instructions.

80.7 Wiring

80.7.1 When the wires in a terminal box or compartment intended for power-supply connections attain a temperature of more than 60°C (140°F) during the Temperature Test, Section 46, the appliance shall be marked with the following statement, or the equivalent, at or near the point where supply connections are made, and located so that it is readily visible during installation: "For supply connection, use wires suitable for at least ___C (___F)." The temperature value to be used in the preceding statement shall be in accordance with Table 80.1.

Table 80.1
Outlet-box marking

Temperature attained during test in terminal box or compartment	Temperature marking
61 – 75°C (142 – 167°F)	75°C (167°F)
76 – 90°C (169 – 194°F)	90°C (194°F)

80.7.2 If any point within a terminal box or wiring compartment of a permanently connected appliance in which field-installed conductors are intended to be connected – including such conductors themselves – attains a temperature more than 60°C (140°F) during the Temperature Test, Section 46, the appliance shall be marked in accordance with 80.7.3. The statement shall be legible and located so that it is clearly visible during installation and examination of the supply-wiring connections.

80.7.3 The marking mentioned in 80.7.2 shall be in accordance with Table 80.1 and the following:

a) When all the conductors used in the test are the same size, the marking shall be "For supply connections use ____ AWG or larger wires suitable for at least _____C (_____F)" or with an equivalent statement.

b) When the test was conducted with 14 AWG (2.1 mm^2) conductors, the wire size marking is not required.

80.8 Cord tag markings

80.8.1 The markings specified in this section shall:

a) Be permanently affixed to an attached power-supply cord,

b) Be located not more than 6 in (152.4 mm) from the attachment plug,

c) Be made of substantial material such as cloth, plastic, or the equivalent that provides the necessary mechanical strength and prevents easy removal, and

d) Comply with the requirements in 69.1 – 69.3. The tag shall be of a size that facilitates legibility of the required markings, and all exposed surfaces shall have a clear plastic overlay, or the equivalent, to protect the markings. The tag shall be either of the following forms:

1) A flag-type tag having a hole to permit securement to the power-supply cord or hose by a plastic strap or equivalent means. The strap shall not be removable without cutting; or

2) A flag-type tag with a adhesive back. The tag is to be wrapped tightly once around and is to adhere to the supply cord or hose. The ends of the tag are to adhere to each other and project as a flag. The required markings are to be positioned on the projecting flag portion of the tag.

Exception: A cord tag marking that complies with the applicable requirements in the Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, for the intended cord surface, specific environmental conditions, suitable temperature rating and limited slippage rating, is not required to comply with the requirements in 69.1 – 69.3.

80.8.2 An appliance provided with a replaceable in-line fuse or fused attachment plug shall be marked "Always Unplug This Product Before Installing or Replacing Fuses."

80.8.3 A cord-connected appliance, as described in Table 15.1, rows 1 and 2, shall be marked:

a) "Do not operate any fan with a damaged cord or plug. Discard fan or return to an authorized service facility for examination and/or repair."

b) "Do not run cord under carpeting. Do not cover cord with throw rugs, runners, or similar coverings. Do not route cord under furniture or appliances. Arrange cord away from traffic area and where it will not be tripped over."

81 Cautionary Markings

81.1 A cautionary or warning marking intended to inform the user of a potential risk of fire, electrical shock, or injury to persons shall be prefixed by the signal word "CAUTION" or "WARNING." The signal word shall be more prominent than any which is intended to reduce the risk of injury, shall be permanent, in capital letters not less than 2.4 mm (3/32 inch) high, and shall be located on a part that cannot be:

a) Removed without impairing the operation of the fan; or

b) Left off the appliance without it being readily apparent.

81.2 A fan provided with an automatic-starting feature in accordance with 27.14 shall be provided with the following marking: "CAUTION" and the following or the equivalent, "Automatically Operated Device – To Reduce The Risk Of Injury Disconnect From Power Supply Before Servicing." The marking shall be visible to the user prior to the performance of intended maintenance or removing of any guard that exposes a moving part that presents a risk of injury to persons.

81.3 An exhaust fan shall be marked with the word "CAUTION" and the following or the equivalent: "To reduce risk of fire and to properly exhaust air, be sure to duct air outside – Do not vent exhaust air into spaces within walls or ceilings or into attics, crawl spaces, or garages." The marking shall be visible during installation.

Exception No. 1: This marking does not apply to the following fan types:

a) Ductless fans intended for use in cooking areas;

b) Room-to-room fans;

c) Bathroom ventilators; and

d) Other non-kitchen type fans.

Exception No. 2: The required information may be included in the installation instructions instead of being marked on the fan if the instructions are packaged and shipped with the fan.

81.4 Fans as specified in Exceptions No. 1 or No. 3 to 9.3.2 or Exception No. 1 to 9.3.4 or Exception No. 2 to 9.3.5 shall be marked with the word "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Injury To Persons, Install Fan At Least 2.1 m (7 Feet) Above The Floor."

81.5 A nonresidential cord-connected fan that is not subjected to the Water Spray Test (see 48.1.1) shall be marked in a readily visible location with the word "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Electric Shock, Do Not Expose to Water or Rain."

81.6 When required by 7.1.3, a fan having play value shall be marked with the word "WARNING" and with the following or the equivalent:

a) "THIS IS A FAN – NOT A TOY!"; and

b) "TO REDUCE THE RISK OF PERSONAL INJURY AND ELECTRIC SHOCK, IT SHOULD NOT BE PLAYED WITH OR PLACED WHERE SMALL CHILDREN CAN REACH IT."

81.7 An outdoor location fan employing a receptacle shall be marked "CAUTION: RISK OF ELECTRIC SHOCK, Do not use with extension cord near water or where water may accumulate. Keep fan at least 16 feet from pools and spas. Keep plugs and receptacles dry."

81.8 When required by 21.20, a fan shall be marked to indicate the type, ampere, and voltage rating of the replacement fuse. In addition, the portable fan shall be marked with the word "WARNING" and the following or equivalent: "For continued protection against risk of fire, replace only with same type and rating of fuse." These markings shall be located adjacent to the fuseholder so as to be visible during fuse replacement.

81.9 A portable fan employing a general use receptacle that is not subjected to the water spray test (see 48.1.1) shall be marked in a readily visible location with the word "WARNING" and the following or equivalent wording: "To reduce the risk of electric shock, do not expose to water or rain."

81.10 A portable fan employing a general use receptacle that is subjected to the water spray test (see 48.1.1) shall be marked in a location adjacent to the receptacle "Wet location only when cover closed."

81.11 An industrial air circulator whose surface temperatures exceed the limits of Table 46.1 (see footnote I), shall be marked with the word “CAUTION” and the following or equivalent wording: "Hot Surface. Avoid Contact." The marking shall be located on the surface in question where visible while operating the actuator.

INSTRUCTIONS

82 Important Safety Instructions

82.1 General

82.1.1 An appliance shall be provided with legible instructions pertaining to:

a) A risk of fire, electric shock, or injury to persons associated with use of the appliance as described in Section 82,

b) Installation as described in Section 83, and

c) User servicing as described in Section 84.

82.1.2 The instructions and warning statements required by Sections 82 – 84 and the applicable Part 2 Instruction Sections shall be provided in an instruction sheet, manual, booklet, or similar printed material and shall be repeated in any electronic media instructions provided. All other instructions may be provided in electronic read-only media format only, such as CD-ROM.

82.1.3 The printed instruction material referenced in 82.1.2 shall contain detailed instructions of how to obtain a printed copy of the material contained in electronic format.

82.2 Details

82.2.1 Important safety instructions in an instruction sheet, manual, booklet, or the like, provided with an appliance shall be separated in format from other instructions, and shall appear before the operating instructions. The instructions shall be legible and shall include the words "READ AND SAVE THESE INSTRUCTIONS", which shall be more prominent than the general text used in the manual, booklet, or the like.

Exception No. 1: The words "READ AND SAVE THESE INSTRUCTIONS" are not required to be included in the instructions for a fan intended only to be used as a component of another appliance.

Exception No. 2: The words "READ AND SAVE THESE INSTRUCTIONS" are not required to be included when the instructions do not include details regarding cleaning, periodic maintenance, or other servicing intended to be performed after installation of fan.

82.2.2 When servicing or replacement of a component in an appliance requires the removal or disconnection of a safety device, the instructions shall include a statement to the effect that the safety device is to be reinstalled or remounted as previously installed.

82.2.3 An appliance having a 2-blade polarized plug shall have the following instructions: "This appliance has a polarized plug (one blade is wider than the other). To reduce the risk of electric shock, this plug is intended to fit in a polarized outlet only one way. If the plug does not fit fully in the outlet, reverse the plug. If it still does not fit, contact a qualified electrician. Do not attempt to defeat this safety feature."

82.2.4 The instruction manual shall:

a) Include instructions pertaining to a risk of fire, electric shock, or injury to persons, for cleaning and user-maintenance, such as lubrication; and

b) Warn the user to unplug or disconnect the appliance from the power supply before servicing.

82.2.5 The markings specified in 88.1 shall also appear in the important safety instructions.

82.2.6 The instructions for a fan that has not been evaluated for operation with a solid state speed control as specified in 87.1.1 – 87.2.1 shall include the signal word "WARNING" and the following or the equivalent: "To Reduce The Risk Of Fire Or Electric Shock, Do Not Use This Fan With Any Solid-State Speed Control Device."

82.2.7 The important safety instructions for a permanently-connected fan shall include, in addition to those items that apply to permanently-connected fans in 82.2.1 – 82.2.6, the following warnings and instructions verbatim and in the order shown:

WARNING – TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

a) Use this unit only in the manner intended by the manufacturer. If you have questions, contact the manufacturer.

b) Before servicing or cleaning unit, switch power off at service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.

Exception: The additional safety instructions do not apply to a ceiling-suspended fan.

82.2.8 The important safety instructions for an exhaust type fan shall include the signal word "CAUTION" and the following statement verbatim: "For General Ventilating Use Only. Do Not Use To Exhaust Hazardous Or Explosive Materials And Vapors."

82.2.9 The important safety instructions for a whole-house fan or attic fan with an unguarded impeller shall include the signal word "CAUTION" and the following statement verbatim: "This unit has an unguarded impeller. Do Not Use In Locations Readily Accessible To People Or Animals."

82.2.10 The important safety instructions for an appliance, as described by rows 1 and 2 of Table 15.1, provided with a replaceable in-line fuse or fused attachment plug shall include the following statement, “This product employs overload protection (fuse). A blown fuse indicates an overload or short-circuit situation. If the fuse blows, unplug the product from the outlet. Replace the fuse as per the user servicing instructions (follow product marking for proper fuse rating) and check the product. If the replacement fuse blows, a short-circuit may be present and the product should be discarded or returned to an authorized service facility for examination and/or repair.”

82.2.11 The important safety instructions for an appliance provided with an AFCI or LCDI shall include the following statement, “This product employs an AFCI/LCDI. If the AFCI/LCDI is de-activated, this indicates an arcing fault, unplug and check the supply cord and product. If no damage is visible, reset the device by pressing the reset button. If the AFCI/LCDI de-activates again, a hazardous condition may be present and the product should be discarded or returned to an authorized service facility for examination and/or repair.”

82.2.12 The important safety instructions for a cord-connected appliance, as described by rows 1 and 2 of Table 15.1, shall include the following statements:

a) “Do not operate any fan with a damaged cord or plug. Discard fan or return to an authorized service facility for examination and/or repair.”

b) “Do not run cord under carpeting. Do not cover cord with throw rugs, runners, or similar coverings. Do not route cord under furniture or appliances. Arrange cord away from traffic area and where it will not be tripped over.”

82.2.13 The important safety instructions for a fan shall include the signal word "WARNING" and the following or the equivalent: "To Reduce The Risk Of Fire, Electric Shock Or Injury To Persons, Do Not Use Replacement Parts That Have Not Been Recommended By The Manufacturer (e.g. Parts Made At Home Using A 3D Printer)."

83 Installation Instructions

83.1 Installation instructions shall be provided with an appliance intended to be permanently connected to the power supply, a cord-connected window, ceiling, or wall-mounted fan, and an appliance provided with keyhole mounting slots.

83.2 Wiring instructions provided with an appliance shall not conflict with any requirement in this standard or in the National Electrical Code, ANSI/NFPA 70.

83.3 A small part not provided with the appliance for mounting shall be referenced in the installation instructions.

83.4 An accessory for a permanently installed fan shall be provided with instructions detailing proper installation procedures.

83.5 When the mounting hardware mentioned in 12.2.1 is not provided with a cord-connected wall-mounted fan, the instructions shall contain a description and an illustration of the hardware needed to mount the fan in place as intended.

83.6 A wall-insert fan described in (b) of Exception No. 2 to 9.3.4 shall be provided with instructions that indicate that the fan is to be installed above a:

a) Counter; or

b) Major appliance, such as a dishwasher or range, that serves as a barrier.

83.7 The instructions provided with those exhaust fans not described in Exception No. 1 to 81.3 shall indicate that the discharge air is to be directed to the building exterior.

83.8 An attic fan that is intended to comply with the Exception to 48.1.1(c) shall be provided with instructions that indicate that the fan is to be mounted behind louvers or in a location where the entrance of drawn in water is unlikely.

83.9 When an appliance is not completely assembled when shipped from the factory and is shipped from the factory in more than one carton, and when misassembly of components results in a risk of fire, electric shock, or injury to persons (see 11.6 and 11.7), the installation instructions shall include the word "WARNING" and the following or the equivalent: "To Reduce The Risk Of Fire, Electric Shock, And Injury To Persons, (Name of Appliance) Must Be Installed With (Name of Part(s)) That Are Marked (on their cartons) To Indicate The Suitability With This Model. Other (Name of Part(s)) Cannot Be Substituted."

83.10 The installation instructions for a permanently-connected fan shall include, in addition to those items that apply to permanently-connected fans in 83.1 – 83.9, all of the following warnings and instructions verbatim and in the order shown and as applicable to the fan type:

WARNING – TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

a) Installation work and electrical wiring must be done by qualified person(s) in accordance with all applicable codes and standards, including fire-rated construction.

b) Sufficient air is needed for proper combustion and exhausting of gases through the flue (chimney) of fuel burning equipment to prevent back drafting. Follow the heating equipment manufacturer's guideline and safety standards such as those published by the National Fire Protection Association (NFPA), and the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and the local code authorities.

c) When cutting or drilling into wall or ceiling, do not damage electrical wiring and other hidden utilities.

d) Ducted fans used to exhaust contaminants must always be vented to the outdoors.

e) If this unit is to be installed over a tub or shower, it must be marked as appropriate for the application and be connected to a GFCI (Ground Fault Circuit Interrupter) – protected branch circuit.

Exception: The additional installation instructions do not apply to a ceiling-suspended fan.

83.11 The installation instructions for a permanently connected appliance as referenced in Exception No. 3 of 7.3.1 shall indicate the product is not intended for connection to rigid metal conduit.

84 User Servicing Instructions

84.1 The instruction manual for an appliance described by rows 1 and 2 of Table 15.1 shall contain specific instructions concerning user servicing. These instructions shall be preceded by the heading “User Servicing Instructions.” The instructions shall include those described in 84.2 and 84.4, as applicable.

84.2 The instruction manual for an appliance employing an AFCI or LCDI shall contain specific instructions concerning user servicing. These instructions shall be preceded by the heading “User Servicing Instructions.” The instructions shall include those described in 84.3 and 84.4, as applicable.

84.3 For products that employ replaceable fuses, the instruction manual shall have specific instructions concerning how to physically replace the fuse. The instructions shall include, but are not limited to the following statements, or equivalent, to successfully replace the fuse and shall include illustrations to assist the user:

a) “Grasp plug and remove from the receptacle or other outlet device. Do not unplug by pulling on cord.”

b) “Open fuse cover.” The manufacturer shall indicate the specific way to open the cover, such as, “Slide open fuse access cover on top of attachment plug towards blades,” or “Push on tabs located next to the blades.”

c) “Remove fuse carefully.” The manufacturer shall indicate the appropriate way to remove the fuse, such as whether to push the fuse from the other side or turn fuseholder over to remove fuse.

d) “Risk of fire. Replace fuse only with ____ Amp, 125 Volt fuse (provided with product).” The blank shall be filled in with the current rating of the fuse. Words located in parenthesis are applicable only if the replacement fuse is provided with the product.

e) “Close fuse cover.” The manufacturer shall indicate the specific way to close the cover, such as, “Slide closed the fuse access cover on top of attachment plug,” or “Push cover closed so that all tabs latch.”

84.4 For products that employ an AFCI or LCDI, the following or equivalent instructions shall be provided and shall include illustrations to assist the user:

"This appliance is provided with a protective device that may make the appliance inoperable under some abnormal conditions. If the appliance becomes inoperable, discard the appliance or return the appliance to a service center for examination and repair. For appliances provided with user- resettable protective devices, the instructions shall:

a) Describe the purpose of the test and reset buttons,

b) Specify the frequency of the testing,

c) Describe the indication of proper functioning of the protective device, and

d) Indicate that an appliance that does not operate in the proper functioning condition is to be discarded or returned to a service center for examination and repair."

84.5 A product employing a fused attachment plug, AFCI, or LCDI shall include the following instructions: “Risk of fire. Do not replace attachment plug. Contains a safety device (fuse, AFCI, LCDI) that should not be removed. Discard product if the attachment plug is damaged.”

PART 2 – SPECIFIC FAN TYPES

FANS FOR USE WITH SOLID STATE SPEED CONTROLS

85 General

85.1 In addition to the applicable requirements in Part 1 of this Standard, a fan for use with a solid-state speed control shall comply with the requirements in Sections 86 – 88. Also see 5.1.

86 Construction

86.1 A motor in a fan that is marked for use with a separate solid-state speed control in accordance with 88.1 and a motor in a residential fan that is provided with an integral solid-state speed control, shall employ overload protection that complies with the tests described in Section 87.

86.2 A solid-state speed control shall comply with the applicable requirements in the Standard for Solid-State Fan Speed Controls, UL 1917, or the equivalent.

Exception No. 1: The spacings of an integral factory wired component solid-state speed control shall comply with either the Standard for Solid-State Fan Speed Controls, UL 1917, or the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series.

Exception No. 2: This requirement does not apply to circuits that comply with the requirements in Supplement SB.

86.3 A permanently connected fan employing a factory wired component solid-state speed control shall include a positive marked “off” position provided by an air-gap-type switch that complies with the applicable requirements in the Standard for General-Use Snap Switches, UL 20, the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or the equivalent. This marking shall be represented by the word “off”, the symbol “O”, or a visual indicator.

Exception No. 1: This requirement does not apply to a fan speed control with the function of electronic disconnection that is additionally evaluated as a protective control in accordance with the Standard for Automatic Electric Controls – Part 1: General Requirements, UL 60730-1.

Exception No. 2: An air-gap-type switch is not required when the factory wired solid state speed control de-energizes only circuits that involve open circuit potentials less than 30 V ac (42.4 V peak), and where the continuous current flow through a 1500 ohm resistor connected across the potential does not exceed 0.5 mA.

Exception No. 3: Electromechanical relays complying with the Standard for Industrial Control Equipment, UL 508, or the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1, provide equivalent air gap isolation to meet the requirement as defined in 86.3.

Exception No. 4: The air gap within wall switches is acceptable as the air gap if the product is provided with installation instructions as defined by 88A.1 or 93.18.

Exception No. 5: For appliances, with motor rated 1/8 hp (100 W) or less, the marked “off” position is not required.

Exception No. 6: This requirement does not apply to circuits that comply with the requirements in Supplement SB. For the purposes of applying Supplement SB, loss of the function of an electronic disconnect shall be considered a Dangerous Malfunction.

87 Performance

87.1 Temperature test

87.1.1 In addition to the condition described in 46.1.11, a fan that includes or that is intended for use with a solid-state speed control is to be operated under each of the following conditions:

a) At the speed and rotation direction resulting in maximum motor temperatures. During this test, the fan is to be connected to the load side of a triac. The triac is to be provided with associated circuitry allowing it to be triggered during each half-cycle of the ac input to the fan. Speed control is to be accomplished by varying the trigger points.

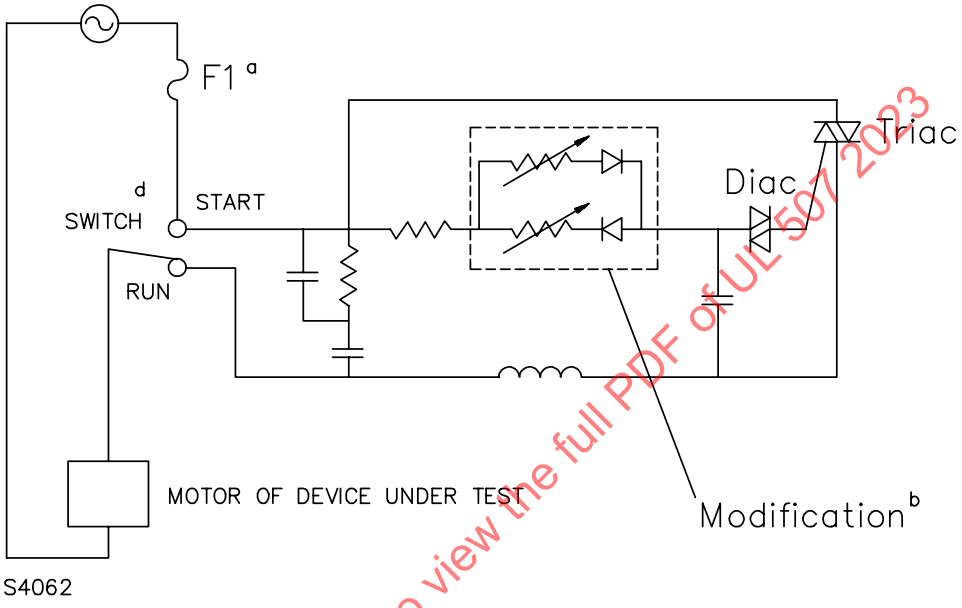
b) Connected and tested as described in (a) with a 2-volt dc offset potential applied to the ac fan input voltage by a suitable method and with the integral solid-state speed control bypassed. The 2-volt dc offset potential is to be obtained by using a speed control device having routing diodes and dual triggering circuits to allow independent adjustment of the positive and negative 1/2 cycle triac triggering points. The triggering points are to be adjusted so that a 2-volt dc bias is measured on the switched ac output waveform. The dc bias may be measured by a dc volt meter having a frequency damped response in the range of 0 – 120 hertz. See Figure 87.1. Alternately, the 2-volt dc offset potential can be obtained by using a power source capable of delivering the proper test voltage along with the 2-volt dc offset.

c) With the fan connected to an ac supply modified to produce half-wave output. The supply is to be switched from sinusoidal to half-wave output after the fan is operating at maximum speed. This test

is to be conducted in the rotation direction and speed control setting resulting in maximum motor temperatures. If after the supply is switched from sinusoidal to half-wave operation, the fan motor shaft does not continue to rotate in a manner that is a usable normal condition, the locked-rotor temperature requirements described in 87.1.2 shall be used instead of the maximum temperature rises specified in Table 46.1. See Figure 87.2.

Figure 87.1

2-volt DC offset test circuit[c]



Footnotes –

[a] The fuse is to protect the test circuit and is to be sized according to the rating of the standard triac module.

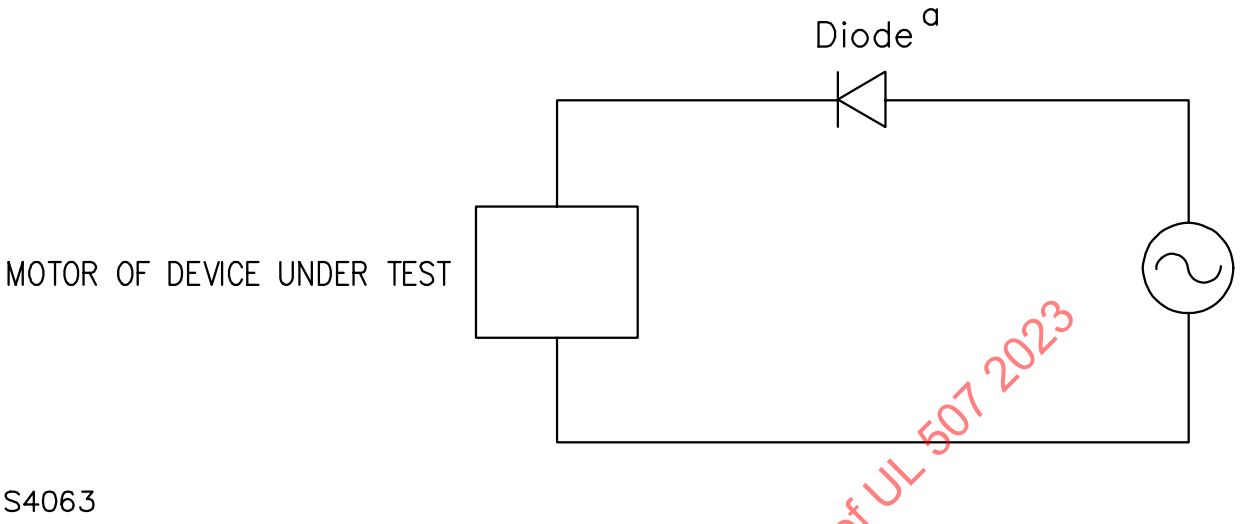
[b] The modification is made to a standard triac module such as a light dimmer or motor controller using two multi-turn potentiometers and two standard rectifier diodes each sized for the rating of the standard triac modules that are used to allow adjustment of the positive and negative portions of the sinusoidal waveform.

[c] Measurement of the test circuit is to be made with a meter having the capability to measure the dc components of the waveform.

[d] The switch allows starting of the device under test with the normal sinusoidal waveform ("Start" position) and then allows switching to the modified waveform ("Run" position).

Figure 87.2

Half-wave test circuit



Footnote –

[a] A standard rectifier diode is used to produce the half-wave input to the motor of the device under test. The diode is to be sized for the rating of the device under test (at least twice the rating of the motor).

87.1.2 When the fan motor shaft does not rotate or rotates in a manner not determined to be normal after the supply is switched from sinusoidal to half-wave operation as described in 87.1.1(c) or, the motor does not restart when operated from a half-wave source after the motor is de-energized, the motor shall comply with the applicable temperature requirements as follows:

a) The temperature of an impedance-protected motor shall comply, under the locked-rotor conditions, with the Locked-Rotor or No-Load Temperature Test requirements in the Standard for Impedance Protected Motors, UL 1004-2.

b) The temperature of a thermally-protected motor shall comply with the Locked-Rotor Temperature Test requirements in the Standard for Thermally Protected Motors, UL 1004-3, except:

1) For a motor with an automatic reset type protective device, the temperature criteria shall not be applied during the initial cycle of the thermal protector operation and there shall be no emission of flame or molten metal, or

2) For a motor with a non-replaceable thermal cutoff, the temperature criteria shall not be applied when the thermal cutoff opens within the first hour and there shall be no emission of flame or molten metal.

87.2 Abnormal operation test

87.2.1 A fan having a thermally protected motor shall comply with the requirements in the Locked-Rotor Endurance Test in the Standard for Thermally Protected Motors, UL 1004-3, and a fan having an impedance-protected fan motor shall comply with the requirements in the Endurance Test in the Standard for Impedance Protected Motors, UL 1004-2, except:

a) No winding temperature requirements are applicable;

b) The motor is to be installed in the fan, and the fan is to be installed as described for the Temperature Test in Section 46 of this Standard; and

c) The duration of the test is for 15 days. The power supply is to be modified to provide half-wave output directly to the motor and bypassing the integral solid-state speed control.

88 Marking

88.1 A fan that has been evaluated for compliance with 87.1.1 – 87.2.1 may be marked with the following or equivalent, "Suitable for use with solid-state speed controls." This marking shall be in a location readily visible both during and after installation. See 82.2.5.

88A Installation Instructions

88A.1 A permanently-connected fan relying on Exception No. 4 of 27.15 or Exception No. 4 of 86.3 to comply with this Standard, shall include the following safety instruction or equivalent: "WARNING – To Reduce The Risk Of Electric Shock, This Fan Must Be Installed With An Isolating Wall Control/Switch".

CEILING-SUSPENDED FANS

89 General

89.1 In addition to the applicable requirements in Part 1 of this Standard, a ceiling-suspended fan shall comply with the requirements in Sections 90 – 93. Also see 5.1.

90 Construction

90.1 Mounting means

90.1.1 A ceiling-suspended fan shall be provided with mounting means and instructions. See 83.1. The mounting means shall comply with the static load test specified in Section 91.

90.1.2 Other than as noted in (a) and (b), the mounting means for a ceiling-suspended fan shall be independent of an outlet box and shall be secured directly to the building structure. See 93.2. A ceiling-suspended fan intended to be mounted directly to the building structure shall be marked in accordance with 92.5.

a) A ceiling-suspended fan intended to be mounted to an outlet box shall comply with the following:

1) The weight of the fan together with the intended combination of accessories installed, including possible loading as specified in 148.4, shall not exceed the cross-referenced outlet box allowable fan support weight (see 92.2);

2) The mounting means shall be tested in accordance with the static load test described in Section 91, Performance;

3) The fan is marked for installation to an outlet box and is marked to instruct the installer to use the mounting screws provided with the outlet box (see 92.2);

4) The installation instructions specify that the fan be mounted to an outlet box and that the mounting screws provided with the outlet box shall be used (see 93.6); and

5) The fan mounting bracket has a maximum thickness of 7.9 mm (5/16 inch).

b) A ceiling-suspended fan provided with two forms of mounting means, such that the fan is capable of being mounted to either an outlet box or directly to a structural framing member, shall comply with the following:

1) The weight of the fan together with the intended combination of accessories installed, including possible loading as specified in 148.4, shall not exceed the cross-referenced outlet box allowable fans support weight (see 92.6);

2) Both mounting means shall be tested in accordance with the static load test described in Section 91, Performance;

3) The fan shall be marked in accordance with 92.6;

4) The installation instructions specify that the fan can be mounted to a structural framing member or an outlet box and that when mounting to an outlet box the screws provided with the outlet box shall be used (see 93.7); and

5) The fan mounting bracket has a maximum thickness of 7.9 mm (5/16 inch).

90.1.3 The mounting of a ceiling fan intended to be suspended by a single "J" hook shall be provided with:

a) A means to reduce the likelihood of rotation and removal of the hook, such as a locking bar; or

b) A short retention chain that would support the fan if the "J" hook were unscrewed.

The threads on the threaded portion of a "J" hook shall be a minimum of 50.8 mm (2 inches) long.

Exception: This requirement does not apply to a unidirectional fan when its starting and operating torques tend to tighten the "J" hook.

90.1.4 Downrods shall be fastened at each end by means that do not depend upon friction alone. Threaded fittings used for this purpose shall be fastened by an additional means, such as a through bolt, lockwasher and nut, or the like. A hardened setscrew that upon installation upsets the threads of a downrod is considered an additional means. An unthreaded downrod shall not be fastened solely by setscrews.

90.1.5 When mounted directly to the building structure, appliance installation shall not expose combustible material.

90.2 Fan blades

90.2.1 The blades of a ceiling-suspended fan shall be located at least 3.05 m (10 feet) above the floor when the fan is installed as intended.

Exception: As an alternative to the 3.05 m requirement, the blades shall not be less than 2.1 m (7 feet) above the floor only when the maximum speed at the tip of the blades, the airflow, and the minimum edge thickness of the blades are as specified in Table 90.1.

90.2.2 If failure of an electronic control could result in blade tip speeds in excess of those allowed by Table 90.1, the required safety functionality shall be additionally evaluated as either:

a) A protective control in accordance with the Standard for Automatic Electric Controls – Part 1: General Requirements, UL 60730-1. See 28.1; or

b) A protective electronic circuit in accordance with Supplement SB.

Table 90.1
Ceiling-suspended fans from 2.1 meters (7 feet) to less than 3.05 meters (10 feet) above floor

Air flow	Maximum speed at tip of blades, m/s	(feet per minute)	Minimum thickness of edges of blades, mm	(inch)
Downward	16.3	(3200)	3.2	(1/8)
Downward	20.3	(4000)	4.8	(3/16)
Upward	16.3	(3200)	4.8	(3/16)
Upward	12.2	(2400)	3.2	(1/8)

90.2.3 The leading and trailing edges of the blades mentioned in 90.2.1 and Table 90.1 shall be smooth and well-rounded with no projections.

90.2.4 The polymeric blades of a dry location ceiling-suspended fan shall comply with all the requirements specified in Section 99, Performance, except for the low temperature conditioning of 99.1.3 which is to be conducted at 0°C (32°F).

90.2.5 Glass shall not be used as a material for ceiling suspended fan blades.

90.3 Power supply connections

90.3.1 A cord-connected ceiling-suspended fan marked for commercial, industrial, or agricultural use in accordance with 92.3 shall be provided with a power supply cord in accordance with Table 15.1 and shall:

a) Have three conductors;

b) Be Type SJ or heavier terminating in an acceptable grounding type attachment plug;

c) Have a length of 0.305 – 0.46 m (12 – 18 inches);

d) Be permanently attached to the fan; and

e) Comply with the requirements of 15.1.3 and 15.2.1 – 15.2.5.

90.4 Wiring

90.4.1 Wiring leads provided in a ceiling-suspended fan for supplying power to an optional light kit installed in the field shall not have exposed bare ends. See 92.4 and 108.1.

90.4.2 Wiring leads terminating in single or multiple connectors provided in a ceiling-suspended fan for supplying power to an optional light kit installed in the field shall be constructed such that the single or multiple connectors physically cannot be mated to each other to create a short circuit.

90.5 Openings in canopy

90.5.1 An open hole in the fan canopy shall not exceed the dimension specified in Table 90.2.

Table 90.2
Maximum size of open holes

Opening shape	Maximum area		Maximum Dimension	
	mm^2	($inch^2$)	mm	(inch)
Slot[a]	967.7	(1-1/2)	9.5 (width)	(3/8)
Square	–		12.7 (side)	(1/2)
Round	–		12.7 (diameter)	(1/2)
Irregular	967.7	(1-1/2)	9.5	(3/8)

[a] A slot between two assembled parts that does not exceed 0.8 mm (1/32 inch) in width is not required to comply with the area limitation.

90.5.2 The total area of one or more open holes shall not be more than 15 percent of the area of the surface in which it is located.

91 Performance

91.1 Static load test

91.1.1 Fans with other than ball-joint hanger means

91.1.1.1 The mounting means for a ceiling suspended fan having other than a ball-joint hanger means shall be tested as specified in 91.1.1.3. After the load is removed, the security of the mounting means to the building structure or outlet box and the security of the connection of the fan to the mounting means shall be as originally installed.

91.1.1.2 With reference to 90.1.3, for a fan intended to be suspended by a single "J" hook, the test specified in 91.1.1.3 shall be conducted:

a) First with the fan installed as intended and supported by the "J" hook; and

b) Second with the "J" hook removed and the fan suspended by the chain only.

91.1.1.3 The mounting means of a fan is to be installed in accordance with the installation instructions provided by the manufacturer. The other parts of the fan are not to be installed. A static load of four times the maximum possible weight of the fan and accessories (including the considerations mentioned in 148.4) is to be gradually applied and then supported for one minute by the installed mounting means.

91.1.2 Fans with ball-joint hanger means

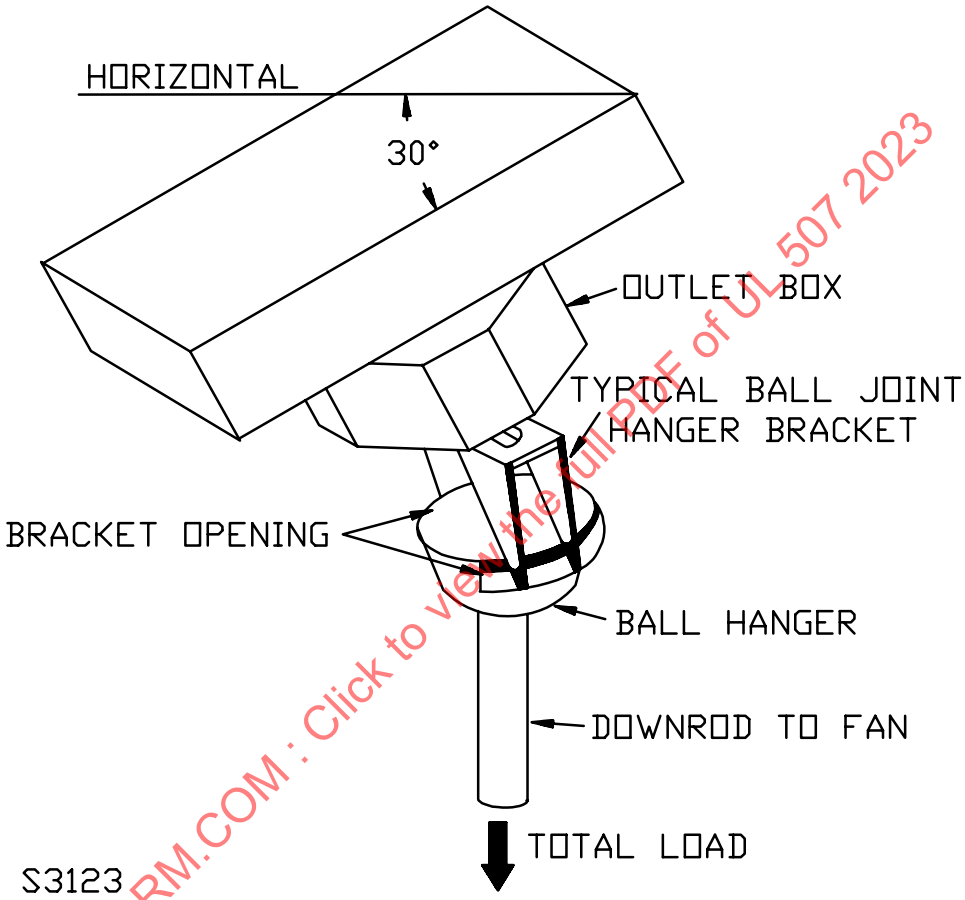
91.1.2.1 After being tested as described in 91.1.2.2, a ball-joint hanger means shall comply with the requirements in 91.1.1.1. When a fan employs a polymeric ball-joint mounting means, the polymeric parts of the hanger are to be conditioned as described in 91.2.2.1 and 91.2.2.2 before testing in accordance with 91.1.2.2.

91.1.2.2 A mounting means for a fan provided with a ball-joint hanger means is to be mounted in accordance with the manufacturer's instructions using the mounting means provided with the fan. The mounting means is to be subjected to a static load of four times the weight of the fan and all accessories for 7 hours. The load is to be applied so as to transmit the maximum stress to the mounting means.

Mounting angle A illustrated in Figure 91.1 is to be 30 degrees; however, the mounting angle may be less than 30 degrees, but not less than 10 degrees, if so recommended in the installation instructions. The load angle is to be in the direction of the hanger bracket opening. If the installation of a canopy could affect test results, the canopy is to be installed in accordance with the installation instructions.

Figure 91.1

Static load test for fans with ball-joint hanger means



91.2 Fans with polymeric mounting means

91.2.1 General

91.2.1.1 Three samples of a ball-joint hanger means incorporating polymeric material shall be installed on the down rods as intended for the ball hanger and shall be tested as described in 91.2.1.2.

91.2.1.2 The samples are to be subjected to the temperature conditioning test of 91.2.2. After the temperature conditioning test, one sample is to be subjected to the endurance test of 91.2.3, and one sample is to be subjected to the static load test of 91.1.2.

91.2.2 Temperature conditioning test

91.2.2.1 As a result of the conditioning described in 91.2.2.2, there shall be no softening, cracking, warping, or other deterioration that decreases the integrity of the polymeric mounting means.

91.2.2.2 Three samples of the polymeric mounting means are to be conditioned for seven hours at 0°C (32°F). For damp or outdoor location ceiling-suspended fans, low temperature conditioning is to be conducted at minus 35.0 ±1.0°C (minus 31 ±1.8°F). The same three samples are then to be conditioned for seven hours in an air-circulating oven maintained at a temperature of 70°C (158°F). The samples are to be cooled to room temperature.

91.2.3 Endurance test

91.2.3.1 After being tested as described in 91.2.3.2, the means used to prevent rotation or twisting between the fan assembly and the hanger assembly shall not be damaged such that it permits rotation or twisting between the assemblies.

91.2.3.2 The same sample of the ceiling-suspended fan, and a sample of the polymeric mounting means that has been conditioned in accordance with 91.2.2.2, are to be mounted in accordance with the manufacturer's instructions. The fan is to be connected to a 60-hertz electrical supply adjusted to the appropriate nominal test voltage specified in Table 40.1. The fan is then to be subjected to 1000 cycles of operation. For a reversible fan, each cycle of operation is to consist of throwing the switch in one direction, allowing the blade to reach full operating speed in that direction; then, without a pause, throwing the switch to the position in which rotation is reversed, allowing the blade to reach full operating speed in that direction. For a unidirectional fan, each cycle of operation is to consist of starting the fan, allowing the blade to reach full maximum operating speed, shutting off the fan, allowing the blade to come to a complete stop.

91.3 Polymeric blades

91.3.1 Following the conditioning described in 91.3.3 – 91.3.6, the polymeric blade-bracket assembly, consisting of a blade attached to the blade brackets, of a ceiling-suspended fan intended for damp locations:

a) Shall not show any signs of blade cracking including the area around the screwholes;

b) Shall not result in the reduction of the minimum blade height allowed on the final installation due to blade warpage; and

c) Shall not result in unacceptable blade warpage as determined by compliance with the Temperature Test, Section 46, using the entire appliance with the conditioned blade-bracket assemblies installed.

Exception: If the input values are within ±10 percent of the before-conditioning values determined in Section 46, the Temperature Test need not be conducted.

91.3.2 The polymeric fan blades in the as-received condition are to be installed on their corresponding brackets with the flathead screws tightened to a maximum torque of 2.82 N·m (25 lbf·in.).

91.3.3 The polymeric blade with bracket assemblies then is to be conditioned at 0 ±1.0°C (32 ±1.8°F) for 7 hours. Following this conditioning, the assemblies are to be allowed to return to room temperature (a minimum of 4 hours).

91.3.4 The assemblies are then to be conditioned at 50.0 ±1.0°C (122 ±1.8°F) at a relative humidity of 80 percent for 7 hours and allowed to return to room temperature (a minimum of 4 hours). See 91.3.5. This sequence described in 91.3.3 and 91.3.4 constitutes one cycle.

91.3.5 Immediately following the conditioning described in 91.3.4, before allowing the samples to return to room temperature, the screws are to be tightened to the torque value applied in 99.1.2.

91.3.6 The cycle described in 91.3.3 and 91.3.4 is to be repeated twice for a total of 3 cycles.

91.4 Fan blade brackets

91.4.1 Static load test for ceiling-suspended fan blade brackets

91.4.1.1 A blade bracket to be used on a ceiling-suspended fan shall be subjected to the static load test described in 91.4.1.2. As a result of the load, the bracket shall have no cracks as determined by visual inspection with a 4-power magnifying glass.

91.4.1.2 The mounting feet of the blade bracket are to be fixed by a support, vise, or other securing means. The bracket is to be oriented as intended for actual use as illustrated in Figure 91.2. After securing the bracket mounting feet, a crossbar is to be secured across the top of the two outermost blade mounting holes. The load is to be suspended from the center of the crossbar for one minute as illustrated in Figure 91.2. The combined weight of the crossbar, load, and means of load suspension is to be in accordance with Table 91.1.

Exception: If the blade bracket construction is such that it is integral to the motor enclosure and attached to the overall motor assembly upon shipment, the blade brackets/motor enclosure can remain attached to the motor assembly during testing.

Table 91.1
Static loads for blade brackets

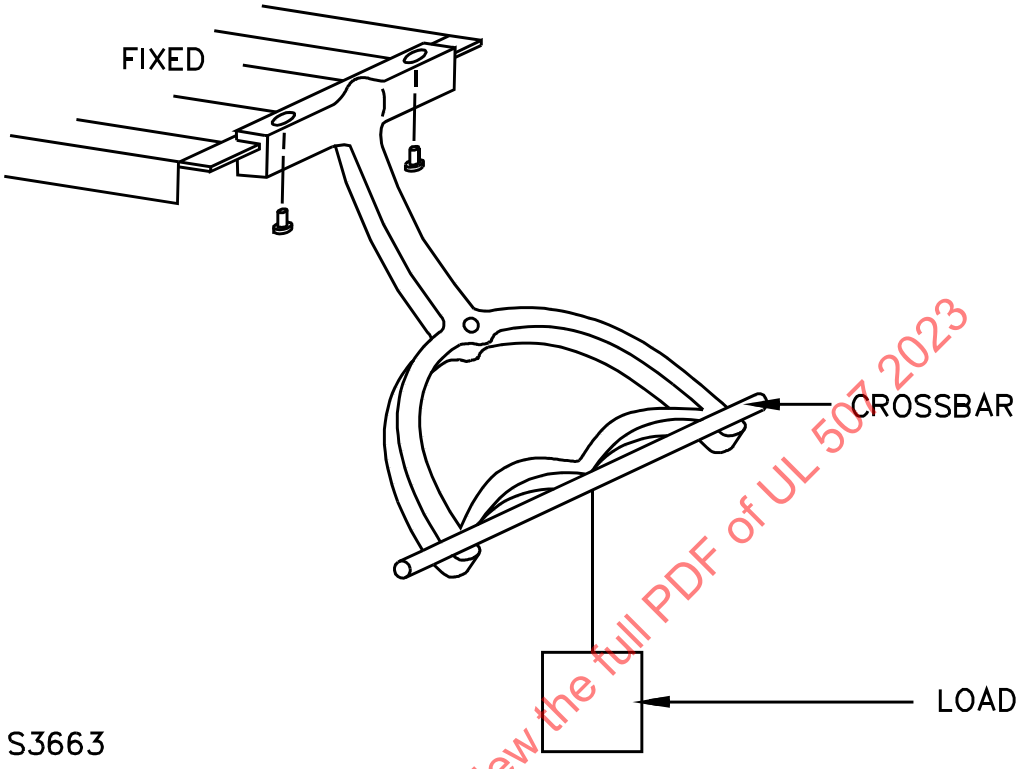
Diameter of ceiling fan[a]	Total static load on sample blade bracket[b]
Less than 1.14 m (45 inches)	9.07 kg (20 pounds)
1.14 m (45 inches) or greater	15.88 kg (35 pounds)

[a] Fan blade span.

[b] Includes weight of crossbar and means of load suspension.

Figure 91.2

Static load test for fan blade brackets



91.4.2 Dynamic load test for ceiling-suspended fan blade brackets

91.4.2.1 A blade bracket to be used on a ceiling-suspended fan shall be subjected to the dynamic load test described in 91.4.2.2 – 91.4.2.4. As a result of the test, the bracket shall have no cracks as determined by visual inspection with a 4-power magnifying glass.

91.4.2.2 The fan blades and blade brackets are to be installed on the test fan in accordance with the manufacturer's installation instructions. The fan blade length and fan speed are to be considered so as to test the fan and blade combinations that represent the most severe dynamic forces that are induced by the 10 gram (0.022 pounds) imbalance described in 91.4.2.3.

91.4.2.3 A 10 gram (0.022 pounds) flat weight is to be secured to the fan blade that will result in the most change in the vertical distance of the blade imbalance. The weight is to be secured to the fan blade at the outermost point from the center of the fan, but not on the edge of the fan blade.

91.4.2.4 The fan is to be operated at maximum normal speed rpm for 24 hours. A reversible fan is to be operated in the upward airflow direction.

92 Marking

92.1 A ceiling-suspended fan shall be marked where readily visible during installation of the fan with the word "CAUTION" and the following or the equivalent: "To Reduce The Risk Of Injury To Persons, Install Fan So That The Blade Is At Least 3.05 Meters (10 Feet) Above The Floor."

Exception: A fan constructed in accordance with the Exception to 90.2.1 shall either be marked as 2.1 m (7 feet) or 3.05 m (10 feet).

92.2 A ceiling-suspended fan which is intended to be supported solely by an outlet box in accordance with 90.1.2(a) shall be permanently marked with the word "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Fire, Electric Shock, Or Personal Injury, Mount To Outlet Box Marked (a) And Use Mounting Screws Provided With The Outlet Box. Most Outlet Boxes Commonly Used For The Support of Luminaires Are Not Acceptable For Fan Support And May Need To Be Replaced. Consult A Qualified Electrician If In Doubt." This marking shall be readily visible during installation. The warning shall also be marked on the carton. See 92.8. Refer to Table 92.2 for appropriate outlet box marking.

92.3 A cord-connected ceiling-suspended fan as mentioned in 90.3.1 shall be marked with the following or the equivalent:

a) Commercial or Industrial Fans are marked "For Commercial or Industrial Use Only," or Agricultural Fans are marked "For Use in Agricultural Buildings"; and

b) "Do not use an extension cord with this fan."

92.4 When a ceiling-suspended fan having provision for installation of an optional, field-installed light kit has leads to be used in the installation, the leads shall be marked or identified as lamp supply leads.

Exception: The leads are not required to be marked or identified when they are the only electrical parts exposed when installing the kit.

92.5 For a ceiling-suspended fan intended to be mounted to the building structure, the mounting bracket shall be marked "WARNING – Support Directly From Building Structure." The marking shall be located on the downward facing side of the mounting bracket and may be on a non-permanent label such as a tag or any type of removable label. The warning shall also be marked on the carton. See 92.8.

92.6 For a ceiling-suspended fan provided with two forms of mounting means in accordance with 90.1.2 (b), the mounting bracket shall be marked "WARNING – To Reduce The Risk Of Fire, Electric Shock, Or Personal Injury, Mount To Outlet Box Marked (a) And Use Mounting Screws Provided With The Outlet Box and/or Support Directly From Building Structure." The marking shall be located on the downward facing side of the mounting bracket and may be on a non-permanent label such as a tag or any type of removable label. The following or equivalent warning shall be marked on the carton: "WARNING – Risk Of Fire, Electric Shock, Or Personal Injury. The Fan In This Box May Be Either Directly Supported From A Structural Framing Member Of A Building And/Or May Be Mounted To An Outlet Box Marked (a). Most Outlet Boxes Commonly Used For The Support of Luminaires May Not Be Acceptable For Fan Support And May Need To Be Replaced. Consult A Qualified Electrician If In Doubt.". Where (a) is the outlet box marking per Table 92.2.

92.7 When the maximum ampere rating for a permanently connected ceiling suspended fan is more than 50 percent of the rating of the branch circuit to which the ceiling suspended fan is intended to be connected, it shall be marked with the following or the equivalent: "Connect Only To A Dedicated Branch Circuit." It shall also be marked on the carton. See 92.8.

92.8 A marking which is required to be located on a carton containing a ceiling-suspended fan shall:

a) Be located on at least one outside surface other than the bottom. The outside surface of a carton for a ceiling-suspended fan is capable of being any side excluding the bottom or may be the top of the carton. When the top of the carton consists of two flaps, the marking is not prohibited from being located only on one flap and the smallest dimension of the carton panel is the size of the flap with the marking; and

b) Appear in lettering not less than the height specified in Table 92.1. The minimum lettering height applies to the capital letters.

Table 92.1
Lettering height

Smallest dimension of the carton panel to be marked in mm (inches)		Minimum height of capital lettering in mm (inches)
More than	Less than or equal to	
0	152 (6)	3.2 (1/8)
152 (6)	254 (10)	4.8 (3/16)
254 (10)	–	6.4 (1/4)

Table 92.2
Outlet Box Marking

Fan Weight		Required Marking
≤ 15.9 kg	(≤ 35 lbs)	"Acceptable for Fan Support of 15.9 kg (35 lbs) or less"
≤ 22.7 kg	(≤ 50 lbs)	"Acceptable for Fan Support of 22.7 kg (50 lbs) or less"
≤ 31.8 kg	(≤ 70 lbs)	"Acceptable for Fan Support of 31.8 kg (70 lbs) or less"

93 Installation Instructions

93.1 The important safety instructions for ceiling-suspended fans shall include the word "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Personal Injury, Do Not Bend The Blade Brackets When Installing The Brackets, Balancing The Blades, Or Cleaning The Fan. Do Not Insert Foreign Objects In Between Rotating Fan Blades."

93.2 The installation instructions for a ceiling-suspended fan shall indicate the method to be used for mounting the fan in accordance with 90.1.2.

93.3 For a ceiling-suspended fan that is intended to be secured to the ceiling by a single screw and is provided with a reversing switch, or has a starting torque that tends to unscrew its single mounting screw, the installation instructions shall indicate that:

a) A lubricant should not be used on the single mounting screw; and

b) The pilot hole should be drilled no larger than the minor diameter of the mounting screw threads, and at least 38 mm (1-1/2 inches) of the threaded part of the mounting screw should be secured into a structural wood joist to provide secure mounting.

93.4 The installation instructions for a ceiling-suspended fan intended to be mounted by a "J" hook shall warn against risk of fire, electric shock, or injury to persons that results from improper installation, and include instructions to attach the chain or locking bar required by 90.1.3.

93.5 Recommendations for the pilot hole for mounting screws shall be provided with the installation instructions. The instructions shall specify that a single "J" hook mounting shall have means to prevent rotation after assembly to the joist through the center of the ceiling box if it is employed with a reversible fan or a fan that operates in a manner that tends to loosen the screws. Reference to this information shall be in accordance with 93.3.

93.6 The installation instructions for a fan which is intended to be supported solely by an outlet box in accordance with 90.1.2(a) shall state "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Fire, Electric Shock, Or Personal Injury, Mount To Outlet Box Marked (a) And Use Mounting Screws Provided With The Outlet Box." Where (a) is the outlet box marking per Table 92.2.

93.7 The installation instructions for a fan which is intended to be mounted to either an outlet box or directly to a structural framing member, in accordance with 90.1.2(b) shall state "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Fire, Electric Shock, Or Personal Injury, Mount Directly To A Structural Framing Member Or To An Outlet Box Marked (a). For Outlet Box Mounting, Use Mounting Screws Provided With The Outlet Box." Where (a) is the outlet box marking in accordance with Table 92.2.

93.8 The installation instructions for a ceiling-suspended fan shall include the information in (a) – (g):

a) A diagram showing the fan, intended mounting means, and ceiling outlet box with fan canopy covering the outlet box;

b) A statement that the installation is to be in accordance with the National Electrical Code, ANSI/NFPA 70 and local codes;

c) A warning to make sure power is off before attempting installation;

d) Instructions that after making the wire connections, the wires should be spread apart with the grounded conductor and the equipment-grounding conductor on one side of the outlet box and the ungrounded conductor on the other side of the outlet box;

e) Instructions that the splices after being made should be turned upward and pushed carefully up into the outlet box;

f) Instructions for supply connections: conductor of a fan identified as grounded conductor to be connected to a grounded conductor of power supply, conductor of fan identified as ungrounded conductor to be connected to an ungrounded conductor of power supply, conductor of fan identified for equipment grounding to be connected to an equipment-grounding conductor; and

g) All instruction sheets shall indicate fan model designation or model series.

93.9 A ceiling-suspended fan which is intended to be supported solely by an outlet box shall have instructions to check that the outlet box is securely installed in place such that it is able to support at least the fan weight.

93.10 Swag kit, light kit, and external motor controller instructions shall not be included unless they are part of the kit that has been investigated for the purpose. Reference may be made in the fan instructions pertaining to proper light or controller accessories by model designation or that they are accessories that have been investigated and found acceptable for use with the fan and that instructions packed with such are to be followed during the installation of the accessory.

93.11 There shall be no illustration of a hanger bracket mounted directly to a ceiling joist, unless located within or over a ceiling outlet-box.

Exception: This requirement does not apply to swag-connected fans and swag kits investigated for the purpose.

93.12 There shall be no illustration of an equipment-grounding lead of a fan connected to a ceiling outlet-box.

93.13 All circuit diagrams shall indicate switching in the ungrounded circuit conductor.

93.14 Instructions shall not include illustrations of hanger assemblies that have not been investigated with the fan.

93.15 When a remote "on-off" wall switch is specified for fan control, instructions shall indicate that the switch used shall have been investigated and found acceptable for use as a general-use switch, as a speed control, or the like.

93.16 The installation instructions for a ceiling-suspended fan shall include the total weight of the fan plus any accessories packaged with the fan.

Exception: The weight is not required to be in the instructions for ceiling-suspended fans that are mounted directly to the building structure.

93.17 If an accessory is not packaged with the ceiling-suspended fan, the installation instructions for the accessory shall include the weight of the accessory.

93.18 A ceiling suspended fan relying on Exception No. 4 of 27.15 or 86.3 to comply with this Standard, shall include the following safety instruction: "WARNING" – To Reduce The Risk Of Electric Shock, This Fan Must Be Installed With An Isolating Wall Control/Switch.

DAMP LOCATION CEILING-SUSPENDED FANS

94 General

94.1 In addition to the applicable requirements in Part 1 of this Standard, a ceiling-suspended fan that is intended for use in damp locations shall also comply with the requirements in Sections 89 – 93, and 167.3. Damp location ceiling-suspended fans are suitable for installation in interior locations protected from weather and subject to moderate degrees of moisture, such as some basements, barns, cold storage warehouses, and similar locations, and also partially protected locations such as under canopies, marquees, roofed open porches, and similar locations.

95 Construction – Protection Against Corrosion

95.1 All inside and outside surfaces of sheet steel or other mechanical parts of iron or steel shall be zinc coated, cadmium plated, enameled, painted, or provided with equivalent protection against corrosion on all surfaces.

Exception: Punched holes and cut edges in ferrous material are not required to be protected against corrosion.

95.2 Hinges, bolts, and fasteners made of ferrous materials shall be protected against corrosion as described in 95.1.

Exception: Hinge pins are not required to be provided with protection against corrosion.

95.3 Sheet steel or other metal that is painted to comply with 95.1 shall be properly cleaned of grease and the like prior to painting.

95.4 Welds in iron or steel (other than stainless steel) shall be painted or provided with equivalent protection against corrosion. Copper, aluminum, alloys of copper and aluminum, stainless steel, and similar materials having inherent resistance to atmospheric corrosion are not required to be provided with additional protection against corrosion.

95.5 Vitreous enamel may be used as the only protective coating for sheet steel having a thickness of 0.66 mm (0.026 inch) or more.

96 Construction – Electrical

96.1 Nonabsorptive electrical insulation shall be used in the construction of electrical components where it is relied upon to provide electrical spacings or sole support of live electrical parts or as electrical insulation. Untreated fiber is an example of material that shall not be used; while treated cellulosic fiber, phenolic, urea, porcelain, and the like, are examples of acceptable nonabsorptive materials.

96.2 A screw shell in a screw shell type lampholder shall not be made of unplated aluminum.

97 Construction – Exposure to Sunlight (Ultraviolet Radiation)

97.1 Polymeric enclosures and fan blades shall comply with the requirements in 167.3, Exposure to sunlight (ultraviolet radiation).

98 Fan Blades

98.1 Glass and medium density fiberboard (MDF) shall not be used as a material for ceiling suspended fan blades.

99 Performance

99.1 Polymeric blades

99.1.1 Following the conditioning described in 99.1.3 – 99.1.6, the polymeric blade-bracket assembly, consisting of a blade attached to the blade brackets, of a ceiling-suspended fan intended for damp locations:

a) Shall not show any signs of blade cracking including the area around the screwholes;

b) Shall not result in the reduction of the minimum blade height allowed on the final installation due to blade warpage; and

c) Shall not result in unacceptable blade warpage as determined by compliance with the Temperature Test, Section 46, using the entire appliance with the conditioned blade-bracket assemblies installed.

Exception: If the input values are within ±10 percent of the before-conditioning values determined in Section 46, the Temperature Test need not be conducted.

99.1.2 The polymeric fan blades in the as-received condition are to be installed on their corresponding brackets with the flathead screws tightened to a maximum torque of 2.82 N·m (25 lbf·in.).

99.1.3 The polymeric blade with bracket assemblies then is to be conditioned at minus 35.0 ±1.0°C (minus 31 ±1.8°F) for 7 hours. Following this conditioning, the assemblies are to be allowed to return to room temperature (a minimum of 4 hours).

99.1.4 The assemblies are then to be conditioned at 50.0 ±1.0°C (122 ±1.8°F) at a relative humidity of 80 percent for 7 hours and allowed to return to room temperature (a minimum of 4 hours). See 99.1.5. This sequence described in 99.1.3 and 99.1.4 constitutes one cycle.

99.1.5 Immediately following the conditioning described in 99.1.4, before allowing the samples to return to room temperature, the screws are to be tightened to the torque value applied in 99.1.2.

99.1.6 The cycle described in 99.1.3 and 99.1.4 is to be repeated twice for a total of 3 cycles.

99.2 Polymeric ball-joint hanger means

99.2.1 Low temperature conditioning is to be conducted at minus 35.0 ±1.0°C (minus 31 ±1.8°F) for 7 hours for the polymeric ball investigation for damp location ceiling-suspended fans.

100 Marking

100.1 A ceiling-suspended fan that complies with the requirements in Sections 94 – 99 and that is intended for use in damp locations shall be marked "Suitable For Use In Damp Locations".

101 Installation Instructions

101.1 A damp location ceiling-suspended fan shall not be provided with any information either on the carton or with the appliance that implies or depicts an outdoor use.

101.2 A damp location ceiling-suspended fan that has provision for installation of a light kit and is marked in accordance with 100.1 shall also be provided with the installation instructions that state "Use Only With Light Kits Marked Suitable For Use In Damp Locations."

WET LOCATION CEILING-SUSPENDED FANS

102 General

102.1 In addition to the applicable requirements in Part 1 of this Standard, a ceiling-suspended fan that is intended for use in wet locations shall also comply with the requirements in Sections 89 – 93, Sections 96 – 101, 167.2 and 167.3. A wet location ceiling-suspended fan is suitable for installation in locations which are unprotected and exposed to weather.

103 Construction

103.1 Corrosion protection

103.1.1 All inside and outside surfaces of a wet location ceiling-suspended fan shall comply with the outdoor corrosion protection requirements described in 166.2.1 – 166.2.5.

103.2 Fan blades

103.2.1 The polymeric blades of a wet location ceiling-suspended fan shall comply with:

a) The requirements specified in Section 99, Performance; and

b) 720 hours of exposure to ultraviolet radiation in accordance with the Ultraviolet Light Exposure Test (UV) in the Standard for Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C.

103.2.2 Glass and medium density fiberboard (MDF) shall not be used as materials for ceiling suspended fan blades.

104 Performance

104.1 A wet location ceiling-suspended fan is to be assembled and mounted in accordance with the manufacturer's installation instructions. The fan is to be mounted to an outlet box acceptable for fan

support. The outlet box is to be recessed and mounted to the "six-inch" side of a 4 by 6 wood beam. The outlet box is to be sealed such that no water enters the outlet box.

104.2 A wet location ceiling-suspended fan shall be subjected to the Water Spray Test of Section 48. The fan is to be subjected to the water spray for 4 hours in the direction most likely to cause water to enter. During the water spray, the fan is to be energized for 1 hour in the upward airflow direction, 1 hour in the downward airflow direction, and then de-energized for 2 hours. For ceiling-suspended fans which operate in only one airflow direction, the fan shall be energized for 2 hours and then de-energized for 2 hours during the water spray.

105 Marking

105.1 A ceiling-suspended fan that complies with the requirements in Sections 102 – 104 and that is intended for use in wet locations shall be marked where visible during installation with the following or equivalent: "Suitable for use in wet locations when installed in a GFCI protected branch circuit."

106 Installation Instructions

106.1 A wet location ceiling-suspended fan that has provisions for installation of a light kit and is marked in accordance with 105.1 shall also be provided with installation instructions that state "Use only with light kits marked 'Suitable for use in wet locations'."

CEILING-SUSPENDED FAN LIGHT KITS

107 General

107.1 In addition to the applicable requirements in Part 1 of this Standard, a ceiling-suspended fan light assembly shall comply with the requirements specified in Sections 108 – 111. Also see 5.1 and 5.4. The ceiling-suspended fan light kit shall also comply with the applicable requirements in the Standard for Luminaires, UL 1598.

108 Construction

108.1 A light kit shall be so constructed that when it is added to a ceiling-suspended fan, the combination does not create a risk of fire or electric shock. See 90.4.1.

108.2 The installation of a light kit shall be restricted to an arrangement that is accomplished mechanically by means of common household tools such as pliers or screwdrivers and electrically by means of plug-in connectors to receptacles provided on the appliance. However, an installation using splices with wire connectors such as wire nuts is not required to have plug-in connections to receptacles.

108.3 A light kit that is shipped disassembled or shipped separately from the fan shall be provided with all hardware, including wire connectors such as wire nuts, necessary to install the light to the fan.

108.4 The screw shell of each lampholder shall be provided with a lead identified for connection to the grounded conductor of the power supply. This lead shall be finished to show a white or gray color and shall be readily distinguishable from the other lead or leads. The supply leads shall have a minimum free length of 152.4 mm (6 inches). A shorter length shall only be used when longer leads increase the risk of fire, electric shock, or personal injury.

108.5 A switch provided for the control of a light kit having an incandescent lamp, and not integral with the lampholder, shall have a current rating at least the maximum current that it controls as determined in accordance with 27.9, and shall be a switch acceptable for the control of tungsten-filament lamps.

Exception: This requirement does not apply to a switch rated at 3 amperes or more and used only for the control of a single candelabra-base lamp.

108.6 For a light kit intended to be mounted to a fan having a power-supply cord, the fan shall have a 3-wire power-supply cord. One wire shall be the equipment grounding conductor.

108.7 A light kit intended for use in a damp location shall comply with the applicable requirements in Sections 94 – 101.

108.8 A light kit intended for use in a wet location shall comply with the applicable requirements in Sections 102 – 106.

108.9 Non-metallic enclosures of neon light kits and non-metallic enclosures and blades of ceiling fans intended for use with neon light kits shall withstand 720 hours of twin enclosed carbon-arc or 1000 hours of xenon-arc conditioning in accordance with the Ultraviolet Light Exposure Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, including flammability, strength and impact.

108.10 Components such as wiring, capacitors, and the like, that are exposed to the neon light kit's UV radiation shall be suitable for UV exposure.

108.11 GTO cable shall be used for the high voltage leads. This cable shall have a voltage rating not less than the maximum secondary-voltage rating of the transformer or power supply with which it is used, including a midpoint-return transformer, and an insulation rated for the temperature involved, but not less than 105°C.

108.12 Polymeric boots and tube supports employed with neon light kits shall comply with the requirements of the Standard for Electric Signs, UL 48.

108.13 Neon transformers shall comply with the requirements of the Standard for Neon Transformers and Power Supplies, UL 2161.

108.14 Neon light kits shall be constructed such that the enclosure cannot be opened without rendering the product inoperable. Closures should be non-standard parts; phillips or straight-slotted screws are unacceptable.

109 Performance

109.1 As part of the investigation, a kit shall be trial-installed to determine that installation is feasible and that the instructions are detailed and correct.

109.2 With the fan installed in accordance with the manufacturer's installation instructions, the ceiling-suspended fan light kit shall comply with the requirements specified in the following tests: Continuity of Grounding Circuit Test, Section 42; Input Test, Section 45; Temperature Test, Section 46; Locked Rotor Test, Section 50; and Dielectric Voltage Withstand Test, Section 47.

109.3 With the fan installed in accordance with the manufacturer's installation instructions, the wet location ceiling-suspended fan light kit shall comply with the requirements specified in the following tests: Continuity of Grounding Circuit Test, Section 42; Input Test, Section 45; Temperature Test, Section 46; Locked Rotor Test, Section 50; Dielectric Voltage Withstand Test, Section 47; and Water Spray Test, Section 48.

110 Marking

110.1 When shipped separately from the fan, each light kit shall be marked with the organization responsible for the product and a distinctive catalog number or equivalent identification.

110.2 When shipped separately from the fan, the light kit shall be marked to indicate the combined electrical input rating of the fan and the light kit. The input marking may be included on the fan when the light kit is packaged with the fan. The marking on the fan, the light kit, or both may be in the form of a recommendation to add the lamp wattage to the fan to determine total input wattage. The marking may be indicated in terms of maximum lamp wattage included in the ratings of the fan.

110.3 A permanent marking shall be provided indicating the maximum lamp wattage to be used. This marking shall be visible during relamping.

Exception: This marking is not required when the light kit complies with all test requirements with:

a) The maximum wattage lamp or lamps that fit in the diffuser or diffusers, and

b) The smallest commonly available diffuser or diffusers.

110.4 When shipped separately from the fan, a light kit intended for use in a damp location shall be marked "Suitable For Use In Damp Locations".

110.5 When shipped separately from the fan, a light kit intended for use in a wet location shall be marked "Suitable for use in wet locations."

110.6 A light kit that is shipped separately from the fan shall be provided with a cautionary statement indicating which fan models are appropriate for use with the light kit. This cautionary statement shall be provided in one of the following forms:

a) The light kit and the carton in which the light kit is sold shall be marked with the word "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install Light Kit Only On Ceiling-Suspended Fan Models Specified In The Installation Instructions Included In This Carton." The marking on the light kit shall be permanent and shall be visible during installation. (Also see 111.3.)

b) The light kit is marked with the word "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, This Light Kit Should Be Used Only With The Fan Models Specified Below:

Models _____ Manufactured By Company _____.

Models _____ Manufactured By Company _____."

The marking on the light kit shall be permanent and shall be visible during installation.

110.7 A light kit marked in accordance with 110.6(b) shall be provided with a carton marking that consists of the word "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install Light Kit Only On Ceiling-Suspended Fan Models Specified On The Light Kit." The fan light kit is not required to be provided with the installation instructions described in 111.3.

110.8 A neon light kit shall be marked with the word "CAUTION" and the following wording: " Risk of Fire and Electric Shock: Do Not Repair or Service This Light Kit. In the event of lamp burnout, this light kit should only be replaced with Model _____, Manufactured by _____."

110.9 A neon light kit shall be marked with the following wording: “Indoor Use Only”.

111 Installation Instructions

111.1 Installation instructions shall be packaged with a light kit which provide sufficient information to enable the light kit to be mounted and connected to the fan as intended.

111.2 The instructions shall include the word: "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Electric Shock, Disconnect The Electrical Supply Circuit To The Fan Before Installing Light Kit." The statement shall precede all others relating to the installation.

111.3 When a light kit is shipped separately from the fan as described in 110.6(a), the installation instructions packaged with the light kit shall include a statement consisting of the word "CAUTION" and the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, This Light Kit Should Be Used Only With The Fan Models Listed Below:

Models _____ Manufactured By Company _____.

Models _____ Manufactured By Company _____."

111.4 The installation instructions for a light kit shall include the weight of the light kit.

111.5 The instruction manual for a neon light kit shall include the word " CAUTION" and the following wording: "Risk of Fire and Electric Shock: Do Not Repair or Service This Light Kit. In the event of lamp burnout, this light kit should only be replaced with Model _____, Manufactured by _____."

FANS FOR USE IN COOKING AREAS

112 General

112.1 In addition to the requirements in Part 1 of this Standard, a fan that is intended for use in cooking areas shall comply with the requirements in Sections 113 – 116. Also see 5.1 and 5.3.

113 Construction

113.1 Motor

113.1.1 The motor of a fan intended for use in a cooking area shall either:

a) Be located so that it is not in the air stream; or

b) Be constructed so that accumulation of grease on the motor windings does not occur – such as by use of a totally enclosed motor as specified in 2.3.19, or by encapsulation of the windings in a material that is resistant to grease; or

c) Comply with the requirements in 114.1.1.

113.2 Duct-connection fitting

113.2.1 A fan for use in cooking areas shall have provision to connect to ductwork. A duct-connection adaptor shall be provided with the fan when the integral duct-connection fitting is of unusual size or shape. An integral duct-connection fitting and a duct-connection adaptor shall comply with 113.2.2 and 113.2.3.

Exception: Rangehood constructed for recirculation only, with no provision for connection to duct system, is not be required to comply with 113.2.1 – 113.2.3.

113.2.2 An integral duct-connection fitting and a duct-connection adaptor for a fan utilized in cooking areas shall be constructed of metal and protected against corrosion by painting, enameling, galvanizing, plating, or an equivalent means.

113.2.3 An integral duct-connection fitting or duct-connection adaptor constructed of polymeric material rated HB or better is acceptable if completely covered on the outside with metal (in accordance with 113.2.2) by the manufacturer such that no polymeric material serves as the sole mounting location for field-installed ductwork.

113.2.4 A fan for use in cooking areas provided with an integral duct-connection fitting that is non-metallic in compliance with 113.3.5 – 113.3.6 and 113.4, shall also be provided with a metallic duct-connection adaptor that complies with 113.2.2 – 113.2.3.

113.3 Enclosures and guards

113.3.1 A reusable metal filter is acceptable as a guard on the intake side of the fan.

113.3.2 The unobstructed distance to a part capable of causing injury to persons shall be not less than 25.4 mm (1 inch) for an opening on the intake side of a fan. When the unobstructed distance to such a part is 25.4 mm or more, the requirements of Table 9.1 apply.

Exception: A part that is mounted less than 25.4 mm from the opening meets the intent of the requirement only when it cannot be contacted by the probe illustrated in Figure 9.2.

113.3.3 Neither side of a fan for use in cooking areas is required to be guarded when:

a) The manufacturer makes available a guard or reusable metal filter complying with the requirements in this Standard; or

b) The fan is marked as specified in 116.2.

113.3.4 Internal wiring, consisting of individual insulated conductors (separate or in a harness) and electrical connections, must be secured so that they cannot be grasped or hooked in such manner that it or related electrical connections are subjected to undue stress.

Exception: Internal wiring complying with the interconnecting cords and leads test requirements of 55 need not be secured.

113.3.5 Non-metallic enclosures shall comply with the requirements in 7.3, Non-metallic enclosures, and Section 8, Flame Spread and Smoke Developed Requirements for Non-Metallic Enclosures and Other Parts of Permanently Connected Equipment.

113.3.6 Non-metallic, including wood, parts other than the enclosure shall comply with the requirements in 7.4, Non-metallic parts other than enclosures.

113.4 Nonmetallic parts – location and volume limitations

113.4.1 Requirements in this section are intended to supplement requirements for non-metallic enclosures located in 7.3, 113.3 and requirements for non-metallic parts other than enclosures located in 7.4, Non-metallic parts other than enclosures.

113.4.2 A non-metallic part, other than glass, located on an external surface facing the cooktop and mounted less than 762 mm (30 inches) from the cooking surface shall be completely shielded from the cooking surface by a metal or glass barrier.

Exception: Non-metallic materials, other than glass, rated HB or less flammable and whose total area is not more than 0.09 m^2 (1 square foot) are not required to be completely shielded from the cooking surface by a metal or glass barrier. See also 113.4.3.

113.4.3 The volume of non-metallic material, other than glass or an outer shell (see 2.2.19) rated 5VA, shall not exceed 1967 cm^3 (120 cubic inches), and shall meet the following flammability requirements in the thickness in which it is used in the fan.

a) 295 cm^3 (18 cubic inches) or less shall all be HB or less flammable.

b) When the material volume of all non-metallic materials exceeds 295 cm^3 (18 cubic inches), the material volume between 295 cm^3 (18 cubic inches) and less than or equal to 1967 cm^3 (120 cubic inches) shall be rated V-1 or less flammable.

c) Non-metallic materials as described in the Exception to 113.4.2 are included in the volume calculation of (a) and (b).

Note 1: Motor end bells or component sub-enclosures (i.e. control enclosure) molded of non-metallic material are included in the volume calculation.

Note 2: Where a non-metallic material is not molded (i.e. foam or fibrous insulation), a weight allowance may be considered in lieu of a volume allowance. Where used, the weight must be used for all materials, both molded and not molded. The weight equivalents are as follows:

1. 259.6 grams or less.

2. When the material weight of all non-metallic materials exceeds 259.6 grams, the material weight between 259.6 grams and less than or equal to 1731 grams shall be rated V-1 or less flammable.

3. The maximum weight of all non-metallic materials shall not exceed 1731 grams.

Note 3: For material other than molded polymeric material, the material may alternatively comply with the equivalent low-density foam or thin film ratings.

Exception No. 1: Non-metallic materials that are enclosed with metal or located within an outer metal shell shall be HB or less flammable and are not included in the volume calculation above.

Exception No. 2: Non-metallic materials that are integral to the construction of an electrical component (i. e. wire insulation, heat shrink tubing, insulated connectors, coil insulation, insulations systems, capacitors, etc.) are not included in the volume calculation above.

Exception No. 3: Rubber gasketing, used for noise or vibration reduction, are not included in the volume calculation above.

Exception No. 4: Nonmetallic materials located outside the outer shell (see 2.2.19) and not located on an external surface facing the cooktop as described in 113.4.2 are not required to comply with these requirements.

113.4.4 Exhaust grills of recirculating hoods shall be rated HB and are not subject to the volume limitations of 113.4.3.

113.5 Receptacles

113.5.1 A convenience receptacle intended for general use shall not be provided on any fan in a cooking area.

113.6 Filters

113.6.1 A filter employed in a fan intended for use in cooking areas shall comply with the Standard for Air Filter Units, UL 900.

Exception: A filter composed entirely of metal does not have to comply with this requirement.

113.7 Cord-connected rangehoods

113.7.1 A cord-connected rangehood shall be limited to residential use only.

113.7.2 A cord-connected rangehood shall be provided with a length of attached flexible cord and an attachment plug for connection to the supply circuit. The type of flexible cord shall be in accordance with 113.7.4, or shall have such properties that it is at least equally serviceable for the application. The length of attached cord shall be within the limits indicated in 113.7.5.

113.7.3 The flexible cord shall be rated for use at a voltage not less than the rated voltage of the rangehood, and shall have an ampacity not less than the current rating of the rangehood. The blade configuration of the fittings shall be such that the rangehood can be connected to the proper supply source (voltage, phase, and the like).

113.7.4 For cord-connected rangehoods, the cord type shall be one of the following: HS, HSO, HSJ, HSJO, S, SE, SO, SOO, ST, STO, STOO, SJ, SJO, SJOO, SJT, SJTO, or SJTOO.

113.7.5 The length of a rangehood cord shall not be less than 18 inches (450 mm) and shall not be more than 48 inches (1.22 m), and shall be measured external to the appliance and include the fittings, while excluding the blades on the attachment plug. The length of a detachable cord set is to be measured from the face of the rangehood plug to the face of the attachment plug, excluding the blades on the attachment plug.

113.7.6 A rangehood intended for use with a detachable cord set shall have male pins that comply with Table 50.1 of the Standard for Attachment Plugs and Receptacles, UL 498. The general purpose configurations of Wiring Devices – Dimensional Specifications, ANSI/NEMA WD 6-220, shall not be used.

113.7.7 The female appliance coupler of the detachable power supply cord shall mate with the male inlet provided on the rangehood. The detachable cord set shall be shipped with the rangehood and shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817.

113.7.8 The attachment plug of a power supply cord for a cord-connected rangehood shall be of the grounding type.

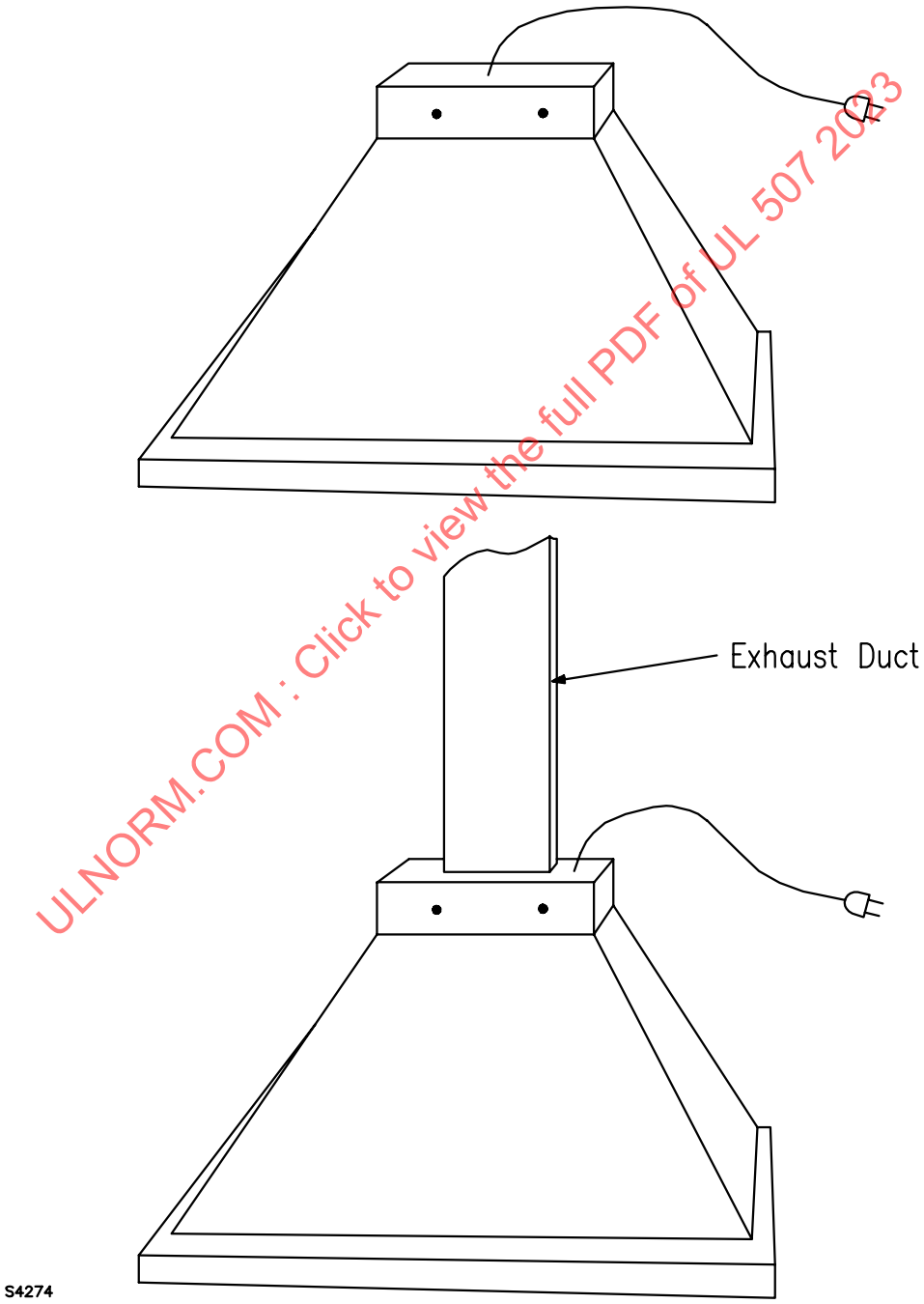
113.7.9 A cord-connected rangehood rated 125 volts or 125/250 volts (3-wire) or less, and employing a lamp- or element-holder of the Edison screw-shell type, or a single-pole switch or overcurrent-protective device other than an automatic control without a marked "off" position shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The terminal or lead so identified shall be the one that is electrically connected to the screw shell of a lamp- or element-holder but to which shall not be connected a single-pole switch or single-pole overcurrent-protective device, other than an automatic control without a marked "off" position.

113.7.10 A flexible power supply cord for a cord-connected rangehood shall not be smaller than 18 AWG (0.82 mm^2).

113.7.11 A flexible power supply cord for a cord-connected rangehood shall vertically exit the top-most horizontal surface of the rangehood. See Figure 113.1.

Figure 113.1

Rangehood with power supply cord exiting top-most horizontal surface



113.7.12 A cord-connected rangehood shall be tested in accordance with Section 41, Leakage Current Test; Section 42, Continuity of Grounding Circuit Test; Section 54, Strain Relief Test; and Section 57, Push Back Relief Test.

113.7.13 A knot shall not be employed to provide strain relief for cord-connected rangehoods.

113.8 Rangehood cord-connection kits

113.8.1 A rangehood cord-connection kit shall comply with the requirements in 113.8.2 – 113.8.9.

113.8.2 For a rangehood cord-connection kit, the cord type shall be one of the following: HS, HSO, HSJ, HSJO, S, SE, SO, SOO, ST, STO, STOO, SJ, SJO, SJOO, SJT, SJTO, or SJTOO.

113.8.3 A rangehood cord-connection kit shall be provided with strain relief.

113.8.4 A knot shall not be employed to provide strain relief for rangehood cord-connection kits.

113.8.5 A rangehood cord-connection kit that is provided with strain relief that complies with the component requirements in the Standard for Insulating Bushings, UL 635, shall be factory installed on the cord and shall comply with Section 54, Strain Relief Test, Section 57, Push Back Relief Test, and the installation test of 114.7.1. Any other means shall comply with Section 54, Strain Relief Test, when installed in accordance with Section 117, Installation Instructions for Rangehoods and Rangehood Cord-Connection Kits.

Exception No. 1: The strain relief is not required to be factory installed when the strain relief can be safely and reliably installed mechanically by means of common household tools such as pliers or screwdrivers.

Exception No. 2: The strain relief is not required to be factory installed when the tool(s) required for proper installation is provided with the rangehood cord-connection kit.

113.8.6 All component parts of the rangehood cord-connection kit shall be provided with the kit.

Exception: Small parts commonly available for the mounting of the rangehood and the rangehood cord-connection kit are not required to be provided when the rangehood cord-connection kit instructions specify these parts for mounting.

113.8.7 As part of the investigation, a rangehood cord-connection kit shall be tested and trial-installed to determine that installation is feasible, that the instructions are detailed and correct, and that the use of the rangehood cord-connection kit does not introduce a risk of fire or injury to persons. See 114.7.1.

113.8.8 The identified (neutral) lead of the power supply cord for a rangehood cord-connection kit shall be white, gray, or shall have three (3) continuous white stripes.

113.8.9 The cord-connection kit, when installed in accordance with the instructions, shall comply with cord length requirements of 113.7.5.

113.9 Light assemblies

113.9.1 An appliance intended for use in a cooking area and employing a light shall comply with the applicable requirements of this standard and with the applicable requirements in the Standard for Luminaires, UL 1598.

113.10 Lamp containment barriers

113.10.1 A rangehood employing tungsten-halogen lamps as the light source shall be provided with a lamp containment barrier that will contain major particles resulting from a ruptured lamp, unless:

a) The lamp manufacturer declares on the lamp package that the lamp is suitable for use in an open luminaire; or

b) The luminaire is intended to be used with a lamp provided with an integral outer lamp envelope, and the lamp manufacturer does not provide a caution requiring an additional lamp containment barrier.

113.10.2 A rangehood employing a tungsten-halogen lamp that does not require an additional lamp containment barrier may be provided with a lamp containment barrier or shall be:

a) Marked with a caution, the maximum lamp wattage, and the type of shielded lamp, in accordance with 116.9(a); or

b) Marked with a caution, the maximum lamp wattage, the type of shielded lamp, and the lamp replacement requirements in accordance with 116.9(b).

113.10.3 A lamp containment barrier shall be secured in position by one of the following methods:

a) Mechanical means that produces an interference fit;

b) Physical fit; or

c) Other similar means.

113.10.4 Open holes in a lamp containment barrier that are located at points where particles from a ruptured lamp are likely to drop and rest or that provide a direct line of sight to the filament from the outside the luminaire shall not permit the passage of a 3.3 mm (0.130 in) diameter rod.

113.10.5 A lamp containment barrier shall be constructed of the following materials:

a) Ceramic;

b) Glass in accordance with Clause 113.10.6;

c) Metal screen;

d) Metal having minimum thickness of 0.41 mm (0.016 in); or

e) Polymeric material in compliance with Clause 113.10.7.

113.10.6 The part of a glass containment barrier where particles from a ruptured lamp are likely to drop and rest shall have a minimum thickness of:

a) 2.4 mm (0.095 in) for luminaires rated less than 100 W; and

b) 3.0 mm (0.118 in) for luminaires rated for 100 W or more.

113.10.7 A polymeric lamp containment barrier, where particles from a ruptured lamp are likely to drop and rest, shall comply with the lamp containment barrier melt-through test of 114.8, comply with the five-inch flame test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or be molded of a material rated 5V.

113.11 Tungsten-halogen lamp voltage incompatibility

113.11.1 The lampholder voltage for a luminaire employing a lamp with a lamp base configuration shown in Table 113.1 shall be 30 V rms, 42.4 V peak, or less, regardless of the nominal luminaire input voltage.

113.11.2 The lampholder voltage for a luminaire employing a lamp with a lamp base configuration shown in Table 113.2 shall be a nominal operating voltage of 120 V.

113.11.3 An adapter shall not be provided to convert a luminaire employing a lamp with a lamp base configuration shown in Table 113.2 (for use at a nominal operating voltage of 120 V) to accommodate a lamp with a lamp base configuration shown in Table 113.1 (for use at 30 V rms, 42.4 V peak, or less) unless the adapter is provided with an integral, isolated, step-down transformer or voltage converter.

Table 113.1

Lamp base configuration, 30 V rms, 42.4 V peak, or less

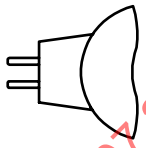
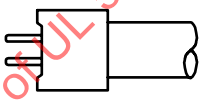
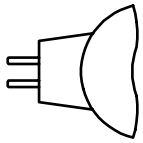
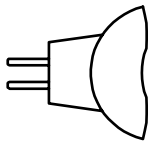
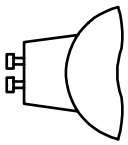
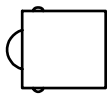
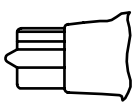
Description	Lamp Base	Lamp Base Physical Shape
Bipin C–C 4 mm (0.157 in)	G4	
Bipin C–C 4 mm (0.157 in)	GU4	
Bipin C–C 5.3 mm (0.209 in)	G5.3	
Bipin C–C 5.3 mm (0.209 in)	GU5.3 GX5.3 GY5.3	
Bipin C–C 6.35 mm (0.250 in)	G6.35 GX6.35 GY6.35	
Bipin C–C 6.35 mm (0.250 in)	GZ6.35	
Bipin C–C 7 mm (0.275 in) Twist and Lock	GU7	
Bipin C–C 8 mm (0.315 in)	G8	
Single Contact Bayonet Candelabra	BA15S	
Wedge	W2.1 x 9.5d	

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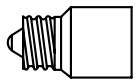
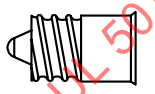
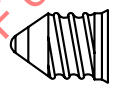
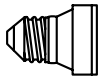
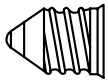
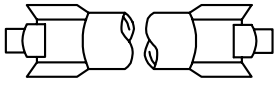
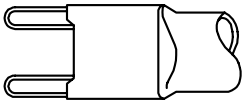
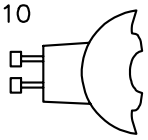
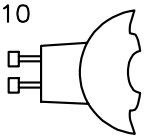
Table 113.2

Lamp base configurations, 120 V nominal

Description	Lamp Base	Lamp Base Physical Shape
Mini—Can Screw	E11	
Candelabra	E12	
Intermediate	E17	
Medium	E26/24	
Medium Skirted	E26/50X39	
Trilite	E26d	
Mogul	E39	
Double—ended	R7S	
Double—ended	RX7S	
Bi—pin C—C 9 mm (0.354 in)	G9	
Bi—pin C—C 10 mm (0.394 in) Twist and lock	GZ10 GU10	GZ10  GU10 

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113.12 Glass rangehood surfaces

113.12.1 Edges of glass accessible during normal use or maintenance shall be seamed, swiped, fire-polished, or similarly treated to eliminate sharpness.

113.12.2 Glass shall be reliably secured so that it cannot be readily displaced during normal use and shall not be less than 0.115 inch (2.92 mm) thick.

113.12.3 With reference to 113.12.2, glass, having a dimension, including a diagonal, more than 12 inches (305 mm) shall be a nonshattering or tempered type:

a) That complies with the requirements in the Standard for Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings, ANSI Z97.1, Class A, or

b) Shall comply with the tempered glass impact test of 114.9.

113.13 Rangehoods with ceiling-mounted luminaire module

113.13.1 For a rangehood that is ceiling mounted and moves down toward the cooking surface when in use, and includes a luminaire that is ceiling mounted and does not move with the rangehood, a glass lens or glass shade that is intended for installation at 40 inches or higher above the cooking surface may comply with the following requirements instead of 113.12.2 – 113.12.3:

a) The glass shall comply with Mechanical Construction, Glass in the Standard for Luminaires, UL 1598;

Exception: Tempered glass having exposed area greater than 3226 cm^2 (500 in^2) can have 2.92 mm (0.115 inch) minimum thickness.

b) Untempered glass shall comply with the Luminaires for Use Above Cooking Equipment, Thermal Shock test in UL 1598; and

c) Instructions for mounting height per 117.8.

114 Performance

114.1 General

114.1.1 A motor as specified in 113.1.1 shall be subjected to the grease-conditioning test specified in 114.3.1. A motor employing an insulation system that has moisture-absorption characteristics is to be subjected to the tests specified in 114.4.1 and 114.5.1.

114.1.2 Any material with a moisture absorption value greater than 1.62 percent (see the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, and the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C), and used as an insulating material between film-coated wires, between uninsulated live parts of opposite polarity, or between uninsulated live parts and dead or grounded metal parts shall comply with the tests specified in 114.4.1 and 114.5.1.

114.1.3 When a motor is tested as specified in 114.3 – 114.5:

a) There shall be no noticeable change or deterioration of the motor insulation with respect to accessibility, mechanical strength, or the like;

b) There shall be no dielectric breakdown or arc-over when subjected to the dielectric voltage-withstand test specified in 47.1, except that the potential is to be applied between current-carrying parts and aluminum foil wrapped tightly over the motor assembly; and

c) The insulation resistance of the motor shall be no less than 50,000 ohms between live parts and interconnecting dead metal parts. Charring or discoloration of the insulation is acceptable unless the insulation flakes or rubs off when rubbed with thumb or finger pressure.

114.2 Temperature test for rangehoods

114.2.1 Household rangehood fans shall not reach a temperature at any point sufficiently high to cause deterioration of any materials used or to exceed temperature rises specified in Table 46.1 when tested as described in 114.2.2 – 114.2.4. For fans intended for use over an eye-level oven, see 46.2.

114.2.2 Household range-hood fans, intended for use over a built-in surface unit, or free-standing range, shall be tested with the specified (marked on nameplate) cooking unit, or shall be tested with a cooking unit which has three 1250 W surface elements and one 2100 W surface element, as follows:

a) The fan unit shall be mounted and operated with the marked clearance above the cooking surface;

b) The test shall be conducted in the wooden alcove described in 114.2.3; and

c) The cooking unit shall be operated under the conditions specified in 114.2.4.

114.2.3 The cooking unit referred to in 114.2.2 shall be located in an alcove formed by three surfaces of 9.5 mm (0.37 inch) fir plywood painted a dull black color and placed in a vertical position to comply with the following:

a) One surface shall extend from the floor to a height of 1.8 m (5.9 feet) at the back of the range and have a width at least equal to that of the range;

b) One surface, on one side of the range, shall extend from the floor to a height of 1.8 m, and from the back to but not beyond the front of the range;

c) One surface, on one side of the range, shall extend from the floor to the top surface of the range, and from the back to but not beyond the front of the range; and

d) All surfaces shall be spaced 12.5 mm (0.5 inch) from the vertical sides of the range body; or in contact with projections on the range that extend 12.5 mm or more beyond the range body.

Exception: An alcove is not required when testing rangehoods which are only intended for installation above a kitchen island's cooking unit as specified in the manufacturer's installation instructions.

114.2.4 The cooking unit referred to in 114.2.2 shall be operated under the following conditions:

a) Pans containing water placed on the surface heater elements shall:

1) Be constructed of sheet steel at least 1.02 mm (0.04 inch) thick;

2) Have flat bottoms and vertical sides with radius of curvature at the junction of sides and bottom not exceeding 9.5 mm (0.37 inch); and

3) Have a bottom plane surface diameter not less than the diameter of the active part of the surface heater element on which the pan is placed and not more than 25 mm (1 inch) larger than that diameter.

b) The depth of water shall be maintained at not less than 25 mm in each pan; sufficient water shall be used at the start of the test to maintain the minimum depth without addition; and

c) Each surface heater element switch shall be turned to the position giving maximum temperature setting for 15 minutes, and then turned to a position giving a temperature setting nearest to half, in order to keep the water boiling, until constant temperatures are reached.

114.3 Grease conditioning

114.3.1 Three samples of a motor are to be completely coated with a minimum 3.2-mm (1/8-inch) thick layer of lard and placed for 30 days in a forced-draft air-circulating oven maintained at a temperature of 150°C (302°F). At the end of the conditioning, each sample shall comply with the requirements in 114.1.3.

114.4 Oven and humidity conditioning

114.4.1 At the end of the second conditioning cycle specified below, each sample shall comply with the requirements specified in 114.1.3. Three samples of a motor shall be placed for 7 hours in a forced-draft air-circulating oven maintained at a temperature of 100°C (212°F). At the end of 7 hours, the samples are to be removed from the oven and conditioned for 48 hours in air having a relative humidity of 88 ±2 percent and a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). The cycle is then to be repeated.

114.5 Grease and humidity conditioning

114.5.1 At the end of the conditioning period specified below, each sample shall comply with the requirements specified in 114.1.3. Three samples of a motor are to be conditioned for 48 hours in air having a relative humidity of 88 ±2 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). After the humidity conditioning, each sample is to be subjected to the grease conditioning specified in 114.3.1.

114.5.2 A coil winding having insulating material that is affected by moisture shall have an insulation resistance of not less than 50,000 ohms between current-carrying parts and interconnected noncurrent-carrying parts after exposure for 48 hours to air having a relative humidity of 88 ±2 percent and a temperature of 32 ±2°C (90 ±4°F). See 114.5.1.

114.6 Tests for cord-connected rangehoods

114.6.1 Cord-connected rangehoods shall be tested in accordance with Section 41, Leakage Current Test; Section 42, Continuity of Grounding Circuit Test; Section 54, Strain Relief Test; and Section 57, Push Back Relief Test.

114.7 Tests for rangehood cord-connection kits

114.7.1 A rangehood cord-connection kit is to be subjected to an installation test in which the kit is to be assembled and installed in accordance with the manufacturer's instructions. The rangehood shall function in the intended manner and shall comply with the tests in 114.7.2.

114.7.2 A rangehood cord-connection kit shall be installed in accordance with the manufacturer's instructions and then tested in accordance with Section 41, Leakage Current Test; Section 42, Continuity of Grounding Circuit Test; Section 54, Strain Relief Test; and Section 57, Push Back Relief Test.

114.8 Polymeric lamp containment barrier melt-through

114.8.1 Three test samples of the polymeric containment barrier shall be subjected to the test. Each test sample shall:

a) Be rectangular and have a minimum dimension of 150 mm (6 in) on each side;

b) Be supported on its outer edges, 300 mm (12 in) above a surface covered by a layer of dry absorbent cotton of a nominal 6 mm (0.25 in) thickness;

c) Be oriented as it would be with the rangehood installed in accordance with its installation instructions; and

d) Be preheated to and maintained at the maximum barrier operating temperature recorded during the normal temperature test.

114.8.2 Three quartz arc tube segments shall be chosen in accordance with Table 114.1 and shall be preheated in an oven to 1100 °C for at least 15 min. Each arc tube segment shall then be removed from the oven and, within 2 s, placed on the thinnest part of each lamp containment barrier, where particles from a ruptured lamp arc tube are likely to drop and rest, with the longitudinal axis of the cylinder perpendicular to the plane of the barrier.

114.8.3 The cotton indicator located below the barrier sample shall not be ignited as result of this test.

Table 114.1
Quartz arc tube test segments

Lamp wattage	Outside diameter		Wall thickness		Weight	
	mm	(in)	mm	(in)	g	(oz)
150 or less	13.3 – 14.7	(0.524 – 0.579)	0.95 – 1.05	(0.037 – 0.041)	0.57 – 0.63	(0.020 – 0.022)
151 to 400	20.5 – 22.7	(0.807 – 0.894)	1.18 – 1.27	(0.046 – 0.050)	1.05 – 1.16	(0.037 – 0.041)
>400	24.5 – 27.1	(0.965 – 1.067)	1.80 – 2.00	(0.071 – 0.079)	3.80 – 4.20	(0.134 – 0.142)

114.9 Glass impact test

114.9.1 A test specimen of tempered glass shall be broken by impact to determine the acceptability of the temper of the glass.

114.9.2 The test shall be conducted at 25 ± 5°C (77 ± 9°F).

114.9.3 The specimen shall be weighed, and the weight of 10 in^2 (65 cm^2) shall be calculated.

114.9.4 The lower surface of the tempered glass specimen shall be covered with adhesive tape to retain the particles when the specimen breaks.

114.9.5 The glass shall be placed on a flat surface and shattered with a center punch at a point 1.18 in (30 mm) from the midpoint on the edge of the glass toward the center. The edge shall be defined as the longest dimension on an irregular shape. When shattered, the glass shall completely dice into particles.

114.9.6 The 10 largest crack-free particles shall be weighed together within 5 min, to avoid further fracture. The total weight shall be less than the calculated weight of 10 in^2 (65 cm^2) of the original specimen.

115 Rating for Cord-Connected Rangehoods

115.1 The maximum ampere rating for a cord-connected rangehood shall not be more than 50 percent of the rating of the branch circuit to which the rangehood is intended to be connected. For example, the rating

shall not be more than 7.5 amperes for a 15-ampere branch circuit, or 10 amperes for a 20-ampere branch circuit.

Exception: Where the rangehood is marked to indicate connection to an individual (dedicated) branch circuit, the maximum ampere rating shall not be more than 80 percent of the branch circuit rating based on Section 210-3, Rating, of the National Electrical Code, ANSI/NFPA 70. See 116.5.

116 Marking

116.1 A fan for use in cooking areas shall be provided with a permanent marking, in capital letters not less than 4.76 mm (3/16 inch) high for an eye-level fan and 6.35 mm (1/4 inch) high for all other fans. The marking shall be located so that it is readily visible after the fan has been installed as intended, and shall call attention to:

a) The need for frequent cleaning of all grease from the fan and from all other grease-laden surfaces;

b) The need for frequent removal and cleaning of any filter unit provided; and

c) The need to exercise care when using cleaning agents or detergents.

116.2 A fan complying with the requirements of 113.3.3(b) shall be marked where readily visible during and after installation of the fan with the word "CAUTION" and the following or the equivalent: "To Reduce The Risk Of Injury To Persons, Install Fan So That The Blade Is At Least 2.1 Meters (7 Feet) Above The Floor."

116.3 A cord-connected rangehood and a rangehood cord-connection kit shall be plainly marked with the word "WARNING" and the following or the equivalent: "To provide protection against electric shock, connect to properly grounded outlets only." This marking is not prohibited from being in the form of a non-permanent cord tag.

116.4 A rangehood cord-connection kit shall be marked with the manufacturer's name and a distinctive catalog number, or equivalent identification.

116.5 When the maximum ampere rating for a cord-connected rangehood is more than 50 percent of the rating of the branch circuit to which the rangehood is intended to be connected, it shall be marked with the following or equivalent:

"Connect Only To A Dedicated Branch Circuit."

116.6 Rangehoods shall be marked "For Residential Use Only" or the equivalent.

116.7 Rangehoods shall be marked with the minimum clearance distance above the cook surface.

116.8 If the rangehood is not completely assembled when shipped from the factory, and is shipped from the factory in more the one carton, the following markings must be utilized:

a) The rangehood shall be marked with the word "CAUTION" and the following wording "To reduce the risk of fire, install only with integral and remote blowers that are recommended for installation with this hood. See Manual Enclosed."

b) The remote or integral blower assembly must be marked "To Complete This Blower, The Hood Assembly Must Be Purchased Separately. See Hood Manual To Determine Suitability."

116.9 A rangehood employing a tungsten halogen lamp and not lamp containment barrier shall be marked:

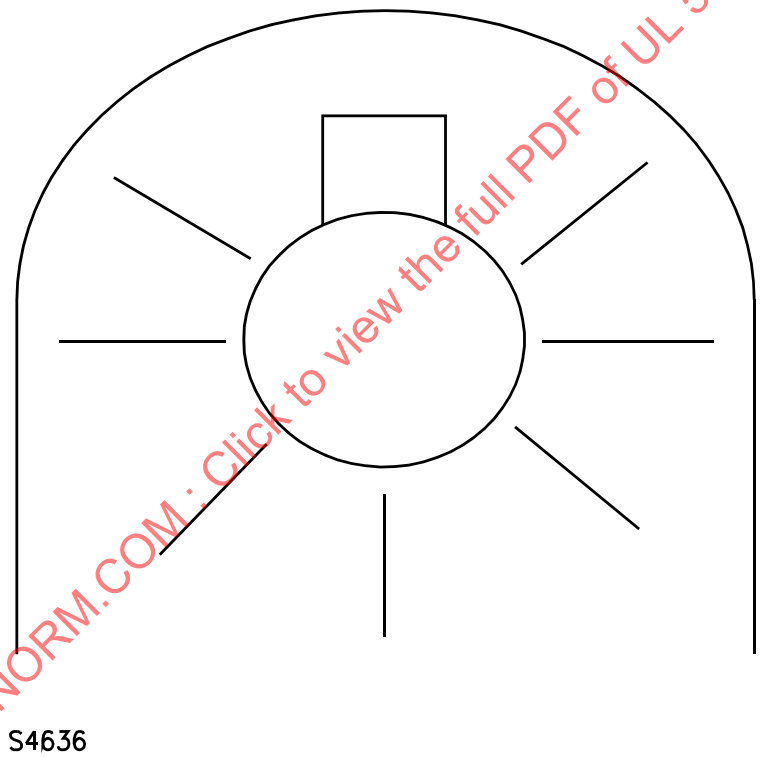
a) "CAUTION – RISK OF FIRE" followed by "MAX ___ WATTS Type ____ SHIELDED or MAX ____ W TYPE ____ SHIELDED", or

b) "CAUTION – RISK OF FIRE" followed by "MAX ___ WATTS Type ___ or MAX ___ W TYPE ___" and Use Lamp Marked "SUITABLE FOR USE IN OPEN LUMINAIRES".

Additionally, the product may be marked with the symbol shown in Figure 116.1, if the product is provided with installation instructions that explain that the symbol on the lamp package is an indication that the lamp does not require additional shielding.

Figure 116.1

Pictogram for an open luminaire



116.10 An accessory ductless conversion kit packaged separately from the rangehood shall be marked with a Model number. The instruction manual provided with the rangehood shall include the following or equivalent, "When used in recirculation mode, To Reduce the Risk of Fire and Shock use only conversion kit Model _____."

117 Installation Instructions for Rangehoods and Rangehood Cord-Connection Kits

117.1 The installation instructions for a rangehood intended for use with remote or integral blowers shall include the word "CAUTION" followed by the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install This Rangehood Only With Remote Blower Models Rated Maximum[a] (Current and/or Horsepower) Or Integral Blowers Manufactured by (Manufacturer's Name), Model(s) (Name of Appliance)." Note: [a] Maximum recommended remote blower rating.

Exception: If the rangehood is not recommended for use with remote blowers the instruction can be amended to state: "CAUTION" followed by the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install This Rangehood Only With Integral Blowers Manufactured by (Manufacturer's Name), Model(s) (Name of Appliance)."

117.2 Installation instructions shall be provided with each cord-connected rangehood that describe the intended mounting and wiring of the cord-connected rangehood.

117.3 Installation instructions shall be provided with each rangehood cord-connection kit that describe the intended mounting and wiring of the rangehood cord-connection kit.

117.4 The installation instructions for a cord-connected rangehood and a rangehood cord-connection kit shall include the following. The word "WARNING" shall be in upper case letters.

"**GROUNDING INSTRUCTIONS**

This appliance must be grounded. In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current. This appliance is equipped with a cord having a grounding wire with a grounding plug. The plug must be plugged into an outlet that is properly installed and grounded.

WARNING – Improper grounding can result in a risk of electric shock.

Consult a qualified electrician if the grounding instructions are not completely understood, or if doubt exists as to whether the appliance is properly grounded.

Do not use an extension cord. If the power supply cord is too short, have a qualified electrician install an outlet near the appliance."

117.5 The installation instructions and packaging of a rangehood cord-connection kit shall include a statement consisting of the word "CAUTION" and the following or equivalent wording:

"To Reduce The Risk Of Fire And Electric Shock, This Rangehood Cord-Connection Kit Should Be Used Only With The Rangehood Models Listed Below:

[Brand Name]: Models _____.

[Brand Name]: Models _____.

117.6 The rangehood installation instructions shall include the following or equivalent:

"Use only with rangehood cord-connection kits that have been investigated and found acceptable for use with this model rangehood."

117.7 The installation instructions for a fan intended for use in cooking areas shall include, in addition to those items that apply to these products in 83.1 – 83.9 and the requirements specified in 83.10, the signal word "WARNING" and the following statement verbatim: "TO REDUCE THE RISK OF FIRE, USE ONLY METAL DUCTWORK."

117.8 For rangehood luminaires per 113.13.1, the installation instructions of the luminaire portion shall include a statement indicating 40 inches minimum clearance between the cooking surface and the bottom part of the lens or glass shade.

118 Safety Instructions

118.1 The important safety instructions for a fan intended for use in cooking areas shall include the following statements verbatim and in the order shown regarding the means for reducing the risk of a range top grease fire:

WARNING – TO REDUCE THE RISK OF A RANGE TOP GREASE FIRE:

a) Never leave surface units unattended at high settings. Boilovers cause smoking and greasy spillovers that may ignite. Heat oils slowly on low or medium settings.

b) Always turn hood ON when cooking at high heat or when flambeing food (i.e. Crepes Suzette, Cherries Jubilee, Peppercorn Beef Flambe').

c) Clean ventilating fans frequently. Grease should not be allowed to accumulate on fan or filter.

d) Use proper pan size. Always use cookware appropriate for the size of the surface element.

118.2 The important safety instructions for a fan intended for use in cooking areas, in addition to those mentioned in 118.1, shall include the following statements verbatim and in the order shown regarding the steps to be taken in the event of a range top grease fire:

WARNING – TO REDUCE THE RISK OF INJURY TO PERSONS IN THE EVENT OF A RANGE TOP GREASE FIRE, OBSERVE THE FOLLOWING[a]:

a) SMOTHER FLAMES with a close-fitting lid, cookie sheet, or metal tray, then turn off the burner. BE CAREFUL TO PREVENT BURNS. If the flames do not go out immediately, EVACUATE AND CALL THE FIRE DEPARTMENT.

b) NEVER PICK UP A FLAMING PAN – You may be burned.

c) DO NOT USE WATER, including wet dishcloths or towels – a violent steam explosion will result.

d) Use an extinguisher ONLY if:

1) You know you have a Class ABC extinguisher, and you already know how to operate it.

2) The fire is small and contained in the area where it started.

3) The fire department is being called.

4) You can fight the fire with your back to an exit.

[a] Based on "Kitchen Firesafety Tips" published by NFPA.

DAMP LOCATION FANS FOR USE IN COOKING AREAS

119 General

119.1 In addition to the applicable requirements in Part 1 of this Standard, a fan that is intended for use in a damp location cooking area shall comply with the requirements in Sections 48, 95, 96, 112 – 121, and 167.3.

119.2 A damp location fan for use in a cooking area shall be provided with means for permanent electrical connection to the power supply.

120 Marking

120.1 A fan that complies with the requirements in Section 119 and that is intended for use in a damp location cooking area shall be marked where visible during installation with the following or equivalent: "Suitable for use in damp locations when installed in a GFCI protected branch circuit."

121 Instructions

121.1 When user servicing or cleaning operations are anticipated, the instructions shall indicate that the electrical supply source be disconnected prior to the beginning of any such servicing or cleaning operation.

121.2 A damp location fan shall not be provided with any information either on the carton or with the appliance that implies or depicts a wet location use.

RANGEHOOD/REMOTE BLOWERS FOR USE IN COOKING AREAS

122 General

122.1 In addition to the applicable requirements in Part 1 of this Standard, a roof mounted remote blower that is intended for use with a rangehood shall comply with the requirements in Sections 48, 114.1 – 114.5, 165 – 167.3, 178, and 179A.

122.2 In addition to the applicable requirements in Part of this Standard, a non-roof mounted remote blower that is intended for use with a rangehood shall comply with 114.1 – 114.5, and Sections 178 and 179A.

123 Construction

123.1 A remote blower switch shall have a voltage, current, and horsepower rating not less than the maximum recommended remote blower rating.

123.2 A remote blower solid state speed control or appliance control shall have a voltage and current rating not less than the maximum recommended remote blower rating.

124 Performance

124.1 The temperature test for rangehoods for use with a remote blower is to be conducted without the remote blower. Blower control circuitry, such as solid state speed controls and switches, should be energized at maximum blower ratings.

125 Marking

125.1 The rangehood shall be marked to indicate the combined electrical input rating of the rangehood and the maximum recommended remote blower rating.

125.2 The rangehood shall be marked with the word "CAUTION" and the following wording: "To reduce the risk of fire, install only with integral and remote blowers that are recommended for installation with this hood. See Manual Enclosed."

125.3 The remote blower assembly shall be marked "To Complete This Remote Blower, The Hood Assembly Must Be Purchased Separately. See Hood Manual To Determine Suitability."

126 Installation Instructions

126.1 The installation instructions for a rangehood intended for use with remote or integral blowers shall include the word "CAUTION" followed by the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install This Rangehood Only With Remote Blower Models Rated Maximum[(a)] (Current and/or Horsepower) Or Integral Blowers Manufactured by (Manufacturer's Name), Model(s) (Name of Appliance)." Note: [a] Maximum recommended remote blower rating.

Exception: If the rangehood is not recommended for use an integral blowers the instruction can be amended to state: "CAUTION" followed by the following or equivalent wording: "To Reduce The Risk Of Fire And Electric Shock, Install This Rangehood Only With Remote Blower Models Rated Maximum[a] (Current and/or Horsepower)."

VENTILATING-HOOD-FAN SHELVES

127 General

127.1 In addition to the applicable requirements in Part 1 of this Standard, a ventilating-hood-fan shelf shall comply with the requirements in Sections 128 – 132.

128 Construction

128.1 A single grounding type convenience receptacle intended for a microwave oven shall be provided on a ventilating-hood-fan shelf. The receptacle shall be mounted on a vertical surface, a horizontal surface above the microwave oven, or another area not susceptible to spills and accumulation of moisture and food matter. The receptacle shall be located where it is unlikely to be used when the microwave oven is unplugged.

Exception: A convenience receptacle is not required when the installation instructions indicate that a duplex receptacle is to be installed near the ventilating-hood-fan shelf for connection of a microwave oven. See 132.5.

128.2 When the electrical rating of a ventilating-hood-fan shelf exceeds 16 amperes, the receptacle circuit for a microwave oven shall have overcurrent protection rated not more than 20 amperes provided as part of the shelf to protect the microwave oven and the receptacle. The overcurrent protection shall be of a type acceptable for branch circuit protection.

128.3 A motor or power transformer in a ventilating-hood-fan shelf rated at more than 16 amperes shall be protected against short circuit and ground fault by an overcurrent device rated to protect the motor or power transformer in accordance with the National Electrical Code, ANSI/NFPA 70. Such a device shall be provided as a part of the shelf unless it is determined that equivalent or better, lower current rated overcurrent protection is obtained from the branch circuit overcurrent protective device through which the shelf is supplied.

128.4 When a ventilating-hood-fan shelf includes a receptacle or a lampholder circuit, the shelf shall include a circuit breaker or fuse rated not more than 20 amperes to protect each of those circuits.

Exception: Such a circuit breaker or fuse is not required when the ventilating-hood-fan shelf is connected in accordance with the National Electrical Code, ANSI/NFPA 70, to a branch circuit rated 20 amperes or less.

128.5 Each circuit breaker, fuse, or other overcurrent protection device in 128.3 and 128.4 shall be a type acceptable for branch-circuit protection of the ventilating-hood-fan shelf.

128.6 A motor having an inherent thermal protector that complies with the requirements for such devices complies with the requirements in 128.3 when the installed ventilating-hood-fan shelf is connected in series with a branch-circuit overcurrent protective device of the same type and has a current rating no more than that used during the tests on the motor protector combination.

128.7 An overcurrent protective device installed in a ventilating-hood-fan shelf shall not be connected in a grounded conductor unless the device opens all the supply conductors simultaneously.

129 Performance

129.1 Ventilating-hood-fan shelf temperature test

129.1.1 General

129.1.1.1 A ventilating-hood-fan shelf intended for use with a microwave oven shall not reach a temperature at any point sufficiently high to cause a risk of fire, to cause deterioration of any material used, or to exceed the temperature rises specified in Table 46.1 when tested with the ventilating-hood-fan shelf installed above a range as described in 129.1.1.2 – 129.1.5.2. In addition, each microwave oven specified in the shelf marking shall not exceed the temperature rise limits specified in the Standard for Microwave Cooking Appliances, UL 923, when operated in conjunction with operation of the shelf and in accordance with the applicable temperature test requirements in UL 923.

129.1.1.2 A ventilating-hood-fan shelf and microwave oven are to be mounted together in accordance with the manufacturer's instructions above at least one of (or any combination of) the following:

a) The standard test gas range described in 129.1.3.1 – 129.1.3.5.

b) The standard test electric range described in 129.1.4.1 – 129.1.4.7.

c) The specific range or ranges marked on the ventilating-hood-fan shelf. See 129.1.5.1 and 129.1.5.2.

129.1.1.3 The markings on the shelf determine which of the three options specified in 129.1.1.2 is chosen, as well as the width of the range heat source. When a standard range is chosen, the shelf is to be tested over the widest range recommended. When the widest recommended range is wider than the shelf, the shelf is also to be tested over a range of the same width as the shelf. Testing above the standard test gas range of a specified width qualifies a ventilating-hood-fan shelf for use above any electric, as well as gas, range of that width without the need for further testing.

129.1.1.4 The test installation is to be as described in 129.1.2.1 – 129.1.2.3. The test is to be conducted in each of the applicable conditions specified in 129.1.1.5 (a) – (e). Wall temperatures surrounding the gas or electric range are not required to be measured. All tests are to be continued until constant temperatures are attained.

129.1.1.5 The test is to be conducted in each of the following applicable conditions:

a) Microwave oven, all range surface units, and the oven operating. The oven is to be set in the bake mode with the center of the oven maintained at an average temperature of 246°C (475°F).

b) Microwave oven not operating, range surface units not operating, and the oven operating in the self-clean mode.

c) The conditions specified in (a) and (b) with the ventilating-hood-fan shelf operating and not operating.

Exception: The test is not required to be repeated with the fan not operating when:

1) The user cannot turn the fan "off" while the receptacle remains energized because of an automatic temperature control;

2) The automatic temperature control withstands 100,000 cycles of intended operation without impaired performance while making and breaking the maximum rated current at rated voltage; and

3) The control complies with the calibration requirements in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series.

d) The conditions specified in (a) and (b) for each intended speed of the ventilating-hood-fan shelf.

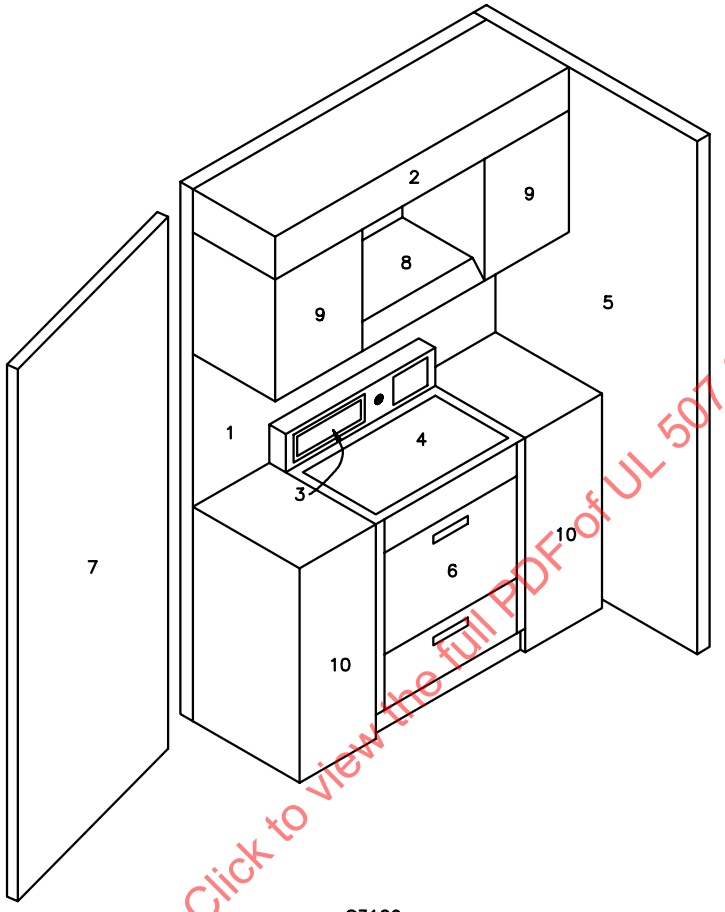
e) The conditions specified in (a) and (b) in the duct position and ductless position when the fan is intended for such operation.

129.1.2 Test installation

129.1.2.1 The panels for the test enclosure and simulated cabinets described in 129.1.2.2 and Figure 129.1 are to consist of a single thickness of 9.52 mm (3/8 inch) plywood or other material of equivalent thermal conductivity. The inside surfaces of the enclosure and outside surfaces of the cabinets are to be painted dull black.

Figure 129.1

Test enclosure for ventilating-hood-fan shelf over counter level range



1. Building back wall
2. Top building cabinet
3. Control panel
4. Cooking surface
5. Building side wall
6. Oven
7. Building side wall
8. Ventilating-hood-fan shelf
9. Upper side cabinet[a]
10. Lower side cabinet[a]

[a] Panels 9 and 10 are not normally used at the same time since the hood fan shelf width matches the range width. Panel 9 is to be used when the shelf width is less than the range width. Panel 10 is to be used when the shelf is more than the range width.

129.1.2.2 The walls of the enclosure are to extend at least to the top of the top building cabinet, and are to project at least 304.80 mm (12 inches) in front of the installed range or shelf. The enclosure is to be firmly assembled with 90 degree angles between the back and the side walls. The walls of the enclosure are to be located as close to the assembly as construction permits – a sliding fit. The side walls then are to be adjusted at the front until contact is established between the test enclosure and the front edges of the assembly at its widest point. See Figure 129.1.

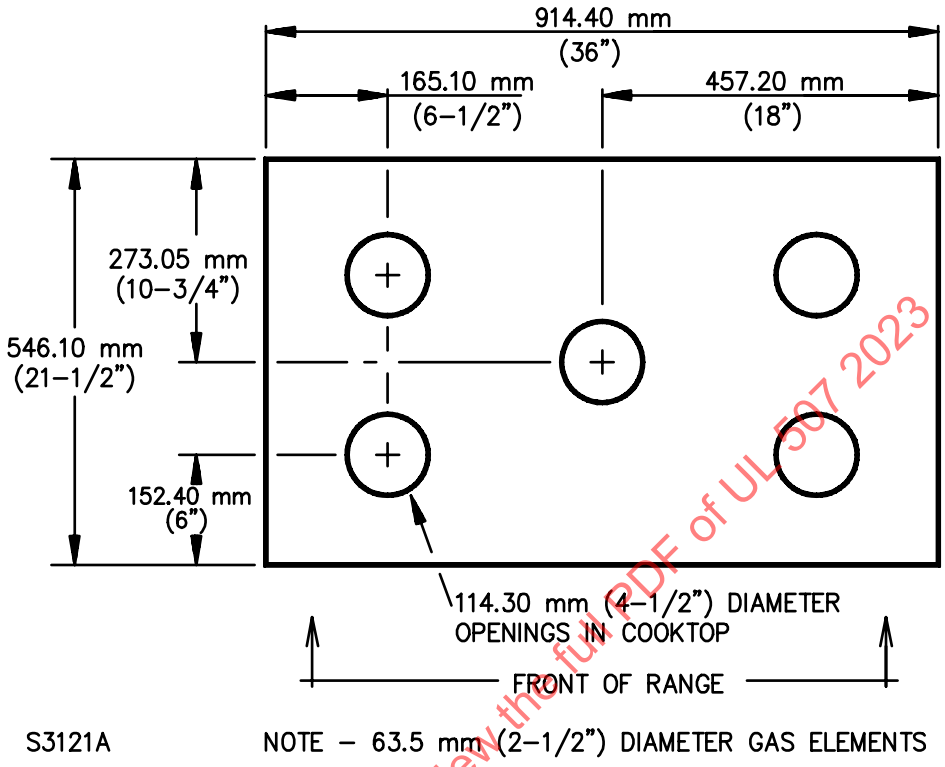
129.1.2.3 The ventilating-hood-fan shelf and range are to be installed in contact with the back wall with the shelf at the shelf manufacturer's minimum recommended height above the range top. A top building structure or cabinet is to be installed immediately above the ventilating-hood-fan shelf, or at the minimum clearance recommended by the ventilating-hood-fan shelf manufacturer to a cabinet, soffit, or the like. The top building cabinet is to be 304.80 mm (12 inches) high, a width sufficient to extend to the side walls of the test enclosure, and 330.20 mm (13 inches) deep, except that it may be of lesser depth if an integral cabinet stop is provided on the ventilating-hood-fan shelf, in which case the cabinet is to be of sufficient depth to extend to the top. When the ventilating-hood-fan shelf is narrower than the range, the fan shelf is to be centered over the range width, and upper side cabinets are to be installed on each side of the shelf to fill the spaces between the shelf sides, the test enclosure walls, and the top cabinet. The base surfaces of the upper side cabinets are to be at the same height above the range as the ventilating-hood-fan shelf base. When the ventilating-hood-fan shelf is wider than the range, the range is to be centered under the shelf width, and lower side cabinets are to be installed on each side of the range to fill the spaces between the range sides, the test enclosure walls, and the floor. The top surfaces of the lower side cabinets are to be at the same height as the range top. All cabinets are to have a solid front panel. See Figure 129.1.

129.1.3 Standard test gas range

129.1.3.1 The standard test gas range to be used is to have a self-cleaning oven and is to have surface burners rated 2.93 kW (10,000 Btu per hour) each and a broiler rated 4.10 kW (14,000 Btu per hour) when supplied with natural gas. A range 762 mm (30 inches) or less in width is to have four surfaces burners. A 914.40-mm (36- inch) wide range is to have five surface burners as described in Figure 129.2.

Figure 129.2

Five-burner standard gas range (top view) (all dimensions nominal)



129.1.3.2 A stove plate is to be placed on each of the two front surface burners when a five burner range is used. When a four burner range is used, the front burner having the highest burner output is to be used. A pan of water is to cover each of the remaining surface burners.

129.1.3.3 The stove plate in 129.1.3.2 is to be circular, cast-iron or steel, 190.50 mm (7-1/2 inches) in diameter, and is to weigh approximately 1.36 kg (3 pounds). The plate is to be flat, but may be ribbed on one side to prevent warping, and it is to be free from rust and other foreign material.

129.1.3.4 The pans mentioned in 129.1.3.2 are to be of aluminum and are to have approximately vertical sides. The diameter of the bottom plane surface of each pan is to be 190.5 mm (7-1/2 inches).

129.1.3.5 The controls for the surface burners covered with a stove plate are to be adjusted to result in a temperature of 246°C (475°F) at the center of the top surface of the stove plate. The control for each surface burner covered with a pan of water is to be adjusted at 888.68 W (3032 Btus per hour).

129.1.4 Standard test electric range

129.1.4.1 When a 762-mm (30-inch) wide or less standard test electric range is to be used, it is to have a self-cleaning oven and four surface elements. When a 914.40-mm (36-inch) wide standard test electric range is to be used, it is to have a self-cleaning oven, four surface elements, and a griddle.

129.1.4.2 The surface units are to consist of two, 152.40-mm (6-inch) diameter, 1200-watt minimum elements; two, 203.20-mm (8-inch) diameter, 2000-watt minimum elements; and, if applicable, a griddle. All elements are to be controlled by a cycling type control.

129.1.4.3 A stove plate as described in 129.1.3.3, except that it is to be 266.70 mm (10-1/2 inches) in diameter and 3.18 kg (7 pounds) in weight, is to be placed on the front 2000 watt element. A pan of water is to be placed on each of the remaining elements. The pans are to be of aluminum and are to have approximately vertical sides. The diameter of the bottom plane surface of each pan is to be no less than the maximum diameter of the active part of the surface unit on which the pan is used, but no more than 25.4 mm (1 inch) larger than that diameter.

129.1.4.4 A control for the 2000 watt element covered with a stove plate is to be adjusted to result in a temperature of 246°C (475°F) at the center of the top surface of the stove plate. An automatic or cycling type control is to be set so that the average temperature at the center of the top surface of the stove plate is 246°C. When a control having a definite number of settings cannot be set to result in this average temperature, the surface unit is to be connected to an external power supply adjusted so that the temperature at the center of the top surface of the stove plate is 246°C.

129.1.4.5 The griddle of the 914.40-mm (36-inch) range is to be operated with its control set so that the temperature at the center of the griddle plate is closest to, but not less than, 246°C (475°F).

129.1.4.6 The control for each 1200-watt element is to be set so that the average power input is 650 watts. The control for the 2000-watt element on which a pan of water is placed is to be set so that the average power input is 833 watts.

129.1.4.7 The broil element is to be rated 3400 watts.

129.1.5 Specific range

129.1.5.1 When a ventilating-hood-fan shelf is intended for use with a specific electric range or ranges, the range or ranges are to be operated as specified in the Standard for Household Electric Ranges, UL 858.

129.1.5.2 When a ventilating-hood-fan shelf is intended for use with a specific gas range or ranges, the range or ranges are to be operated using the stove plates and pans of water noted in 129.1.3.2 – 129.1.3.4. The control for the surface burner covered with a stove plate is to be adjusted to result in a temperature of 246°C (475°F) at the center of the top surface of the stove plate. The control for each burner covered with a pan of water is to be adjusted so that the power input to the burner is not less than:

a) 50 percent of rated power input for a burner rated 1200.54 W (4096 Btu per hour) or less; or

b) 400 watts plus 1/6 of the power rating of the burner in watts.

129.2 Strength of mounting test

129.2.1 During the test described in 129.2.2, the support brackets, hangers, and the like, for a ventilating-hood-fan shelf intended to support a microwave oven shall not deform, crack, break, bend, or the like, to the extent that a ventilating-hood-fan shelf or microwave oven would fall, and the shelf shall not pull out from the mounting surface.

129.2.2 The complete shelf unit is to be mounted in accordance with the manufacturer's instructions, using the brackets, hangers, and the like, that are provided with the shelf as shipped. A weight equal to four times the weight of the heaviest specified microwave oven is to be placed on the shelf for 1 hour. The weight is to be distributed evenly over the surface of the shelf provided for the microwave oven, with the center of gravity located directly above the center of the shelf surface provided for the microwave.

129.2.3 When specific wall constructions are described in the manufacturer's installation instructions, the ventilating-hood-fan shelf is to be tested with each construction.

129.2.4 When no construction is described or when the construction described does not represent expected wall constructions, then the test shall be conducted with wall constraints as follows:

a) A 9.5-mm (3/8-inch) thick trade size gypsum dry wall fastened to trade size 2 by 4 inch wood studs spaced on 406.40-mm (16-inch) centers is to be used as the support surface. The hardware is to be applied as specified in the instructions, and the mounting screws are to be positioned between the studs and secured into the gypsum dry wall. An adjustable product is to be adjusted to the position that gives the maximum projection from the wall. When the manufacturer's installation instructions indicate the mounting screws are to be secured into wood studs:

1) A shelf less than 812.80 mm (32 inches) wide is to be mounted on one side to a wood stud and on the other side to the dry wall, even when the instructions recommend securement to two studs.

2) A shelf at least 812.80 mm (32 inches) wide is to be mounted to a wood stud on each side.

b) A 12.7-mm (1/2-inch) thick trade size gypsum dry wall fastened to trade size 2 by 4 inch wood studs spaced on 609.60 mm (24 inch) centers is to be used as the support surface. The hardware is to be applied as specified in the instructions, and the mounting screws are to be positioned between the studs and secured into the gypsum dry wall. An adjustable product is to be adjusted to the position that gives the maximum projection from the wall. When the manufacturer's installation instructions indicate the mounting screws are to be secured into wood studs, then a shelf is to be mounted on the lightest side to a wood stud and on the other side to the dry wall, even if the instructions recommend securement to two studs.

129.3 Tipover test

129.3.1 A microwave oven installed as intended on a ventilating-hood-fan shelf shall not tip or move from the specified horizontal position during the test described in 129.3.2.

129.3.2 With a 23 kg (50 pound) weight attached to the outer edge of the open door of the microwave oven, the door is to be opened to the position that causes the greatest tendency to tip the oven. The weight is to be maintained for 1 hour.

130 Ratings

130.1 The current rating of a ventilating-hood-fan shelf shall include the rating of the maximum acceptable microwave oven load for the single receptacle provided as part of the shelf and intended for a microwave oven.

131 Marking

131.1 A ventilating-hood-fan shelf intended for use with a microwave oven shall be marked, in a location visible during installation of the microwave oven, with the following words or the equivalent, as applicable, "For use only with (manufacturer's name) (model number or numbers) microwave oven or ovens." The marking also shall be included on the shipping carton.

131.2 A ventilating-hood-fan shelf intended for use only with a specific gas or electric range or ranges shall be marked in a location visible during installation with the following words or the equivalent, as applicable, "For use only with (manufacturer's name) (model number or numbers) gas/electric range or ranges." The marking shall also be included on the shipping carton.

131.3 When a ventilating-hood-fan shelf is not intended for use only with a specific manufacturer's model range, it shall be marked to indicate the maximum width of the range over which it is intended to be used.

When the shelf is intended to be used only with an electric range, it shall be marked with the following words or the equivalent, "Not for installation above gas cooking equipment." When the shelf is intended to be used above a gas or electric range, it shall be marked with the following words or the equivalent, as applicable, " Suitable for use above gas or electric cooking equipment." All markings shall be located so as to be visible during installation.

132 Installation Instructions

132.1 The installation instructions for a ventilating-hood-fan shelf intended for use with a microwave oven shall include the following or the equivalent, as applicable, "For use only with (manufacturer's name) (model number or numbers) microwave oven or ovens."

132.2 The installation instructions for a ventilating-hood fan shelf intended for use only with a specific gas or electric range shall include the following or the equivalent, as applicable, "For use only above (manufacturer's name) (model number or numbers) gas/electric range or ranges."

132.3 The installation instructions for a ventilating-hood fan shelf not intended for use only with specific manufacturer's model ranges shall indicate the maximum width of the range above which it is intended to be used. When the shelf is intended to be used only above an electric range, the following or the equivalent shall be included, "Not for installation above gas cooking equipment." When the shelf is intended to be used above a gas or electric range, the following words or the equivalent shall be included, "Suitable for installation above gas or electric cooking equipment."

132.4 Ventilating-hood-fan shelf installation instructions shall include the minimum recommended installation clearances between the ventilating-hood-fan shelf and:

a) A cook surface; and

b) A top cabinet, soffit, or the like.

132.5 The installation instructions for a ventilating-hood-fan shelf that does not employ a convenience receptacle in accordance with the Exception to 128.1 shall indicate that a duplex receptacle is to be installed near the ventilating-hood-fan shelf for connection of a microwave oven.

RECREATIONAL VEHICLE FANS

133 General

133.1 These requirements cover ventilating fans intended for permanent installation in recreational vehicles in accordance with Article 551 of the National Electrical Code, ANSI/NFPA 70.

133.2 These requirements cover portable ventilating fans and portable ventilating fan/light combinations for use in recreational vehicles.

133.3 A recreational vehicle fan rated 120 volts shall comply with the applicable requirements of Part 1 of this Standard. Requirements in Sections 134 – 137 for fans rated 24 volts or less supplement and amend the applicable requirements in Part 1.

133.4 A recreational vehicle fan intended for use in a cooking area shall additionally comply with the requirements of Sections 112 – 116 of this standard.

133.5 Portable ventilating fan/light combinations shall comply with the applicable requirements of this standard and also with the applicable requirements in the Standard for Low-Voltage Lighting Fixtures for Use in Recreational Vehicles, UL 234.

134 Construction

134.1 Means of mounting

134.1.1 An acceptable means for permanent mounting shall be provided as determined by the Vibration Test, 135.6.1 – 135.6.4.

134.1.2 A mounting means other than bolts or screws shall be investigated to determine whether it is acceptable for the purpose. Keyhole slots for mounting screws may be provided when there is at least one round hole of appropriate size for accommodation of a permanent mounting screw.

134.2 Diffusers and lenses

134.2.1 A diffuser or lens of a recreational vehicle fan shall be of a material specified in 113.3.5.

134.2.2 A diffuser, lens, or decorative part shall be securely positioned away from contact with any lamp or current-carrying part.

134.3 Supply connections – 24 volts or less

134.3.1 Wire leads shall be provided for connection to the source of supply.

134.3.2 The wire shall not be smaller than 18 AWG (0.82 mm^2).

134.3.3 Wire leads shall also comply with the requirements in 14.4.9.

134.3.4 The terminals or pigtail leads shall be accessible for inspections through an access cover and the like without having to disassemble the fan, other than to remove a lens, diffuser, grill, or the like.

134.4 Wiring

134.4.1 Wire shall be stranded copper of an ampacity acceptable for the application when considered with respect to the conditions in 19.3.

134.4.2 Thermoplastic insulation on wires and rubber insulation on wires having a saturated braid shall not be less than 0.76 mm (0.030 inch) thick; neoprene insulation on wires shall be not less than 1.2 mm (3/64 inch) thick.

134.4.3 Each lead to an adjustable lampholder shall be of stranded wire and shall be of such length that adjustment of the lampholder does not transmit stress or cause damage to the lead or connection.

134.5 Electrical components

134.5.1 A lampholder may be a single- or double-contact bayonet-base or other type acceptable for the lamp base intended, and shall be marked in accordance with 137.2.

134.5.2 A motor shall be provided with overload protection in accordance with one of the following:

a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3.

Exception: A motor that has the impeller driven directly from its shaft need comply only with the requirements for protection during locked-rotor conditions.

b) Impedance protection complying with the requirements in the Standard for Impedance Protected Motors, UL 1004-2. A fan in which the motor is subjected to conditions such as restricted ventilation, proximity to external source of heat, and the like, may require an additional investigation.

134.5.3 When a multispeed motor is provided with protection in accordance with the requirements in 134.5.2, the protection shall function acceptably to accomplish the intended result in each setting of the speed-control device.

134.5.4 With reference to 134.5.2, the protection shall comply with the requirements for the voltage rating marked on the motor (in series with the thermal protector during the short circuit test specified in the Standard for Overheating Protection for Motors, UL 2111), and the rating of the series fuse shall be not less than that specified in 137.1 and Table 137.1.

134.5.5 When a multispeed motor is not provided with protection in accordance with the requirements in this section, and when the protection with which the fan is provided upon installation does not function to protect the motor for one or more settings of the speed-control device, protection at each setting shall be provided as part of the fan.

134.5.6 A switch of 24 volts or less shall have current and voltage ratings in accordance with 134.5.7 and 134.5.8.

134.5.7 A switch of 24 volts or less used to control an incandescent lamp load shall have:

a) A current rating for a tungsten filament load equal to or greater than the current measured during the Input Test described in 135.1.1; or

b) If not rated for a tungsten filament load, a current rating at least 10 times the current measured during the Input Test.

Exception: A switch of 24 volts or less that has been investigated and found to be acceptable for the intended use is not required to comply with the current rating requirements in (a) and (b).

134.5.8 A switch of 24 volts or less in a fan intended for nominal 12 volt dc use shall be rated not less than 14 volts dc.

Exception: A switch of 24 volts or less marked with the voltage rating "125 VT" is acceptable for controlling a tungsten load in a dc circuit when the current rating of the switch is not less than the load controlled.

135 Performance

135.1 Input test – 24 volts or less

135.1.1 The current input of a recreational vehicle fan shall be not more than 110 percent of rated value when the appliance is operated under conditions of intended service and with the fan connected to a supply circuit of rated voltage in accordance with Table 135.1.

Table 135.1
Test potential (dc volts) to be applied

Nominal circuit voltage	Voltage during input and temperature tests
6	7
12	14
24	28

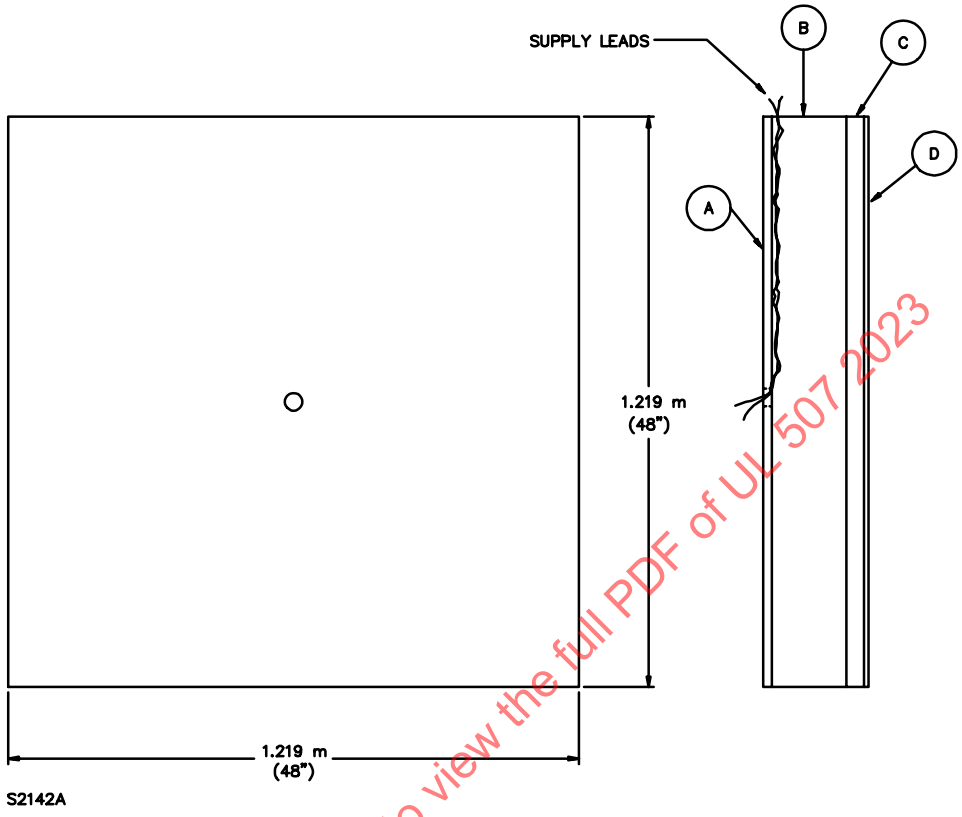
135.2 Normal temperature test – 24 volts or less

135.2.1 When tested in accordance with Section 46, Temperature Test, and with the test voltages of Table 135.1, a recreational vehicle fan shall comply with the temperature rises specified in Table 46.1.

135.2.2 A fan is to be mounted to a ceiling or wall as intended by construction or in accordance with manufacturer's literature, as illustrated in Figure 135.1. If movement is possible, the fan is to be in the most severe position with respect to the enclosure and other parts of the appliance. However, if the fan is marked for a specific ceiling or wall mount structure different from that illustrated in Figure 135.1, it is to be mounted in that ceiling or wall in accordance with the manufacturer's installation instructions.

Figure 135.1

Test ceiling



Materials:

A = Fiberboard, 6.35 mm (1/4 inch) thick.

B = Fiberglass thermal insulation, 50.8 mm (2 inches) thick.

C = Air space, 12.7 mm (1/2 inch).

D = Aluminum sheet, 0.508 mm (0.020 inch) thick.

Notes:

1. Supply connections to be made by two 14 AWG (2.1 mm^2) leads, rated for at least 90°C (194°F), routed between thermal insulation and front panel to supply connection hole.

2. It may be necessary to cut appropriate size mounting hole for ceiling-mounted exhaust fans or wall fans.

135.3 Dielectric voltage-withstand test – 24 volts or less

135.3.1 While in a heated condition, a recreational vehicle fan shall withstand for 1 minute without breakdown the application of a potential starting at zero and gradually increased to 500 volts direct current or 355 volts at 60 hertz and maintained at that level for 1 minute. The increase in applied potential is to be at a substantially uniform rate as rapid as is consistent with correct indication of its value by a voltmeter.

135.4 Abnormal operation test – 24 volts or less

135.4.1 The Normal Temperature Test, 135.2.1 and 135.2.2, shall be repeated with each of the test voltages as specified in Table 135.2, for 7 hours.

135.4.2 Following this test, the recreational vehicle fan shall comply with the Dielectric Voltage-Withstand Test, 135.3.1, and there shall be no indication of emission of flame or molten metal and no distortion of the material.

Table 135.2
Test voltage for abnormal operation test direct current

Rated voltage	Minimum test voltage	Maximum test voltage
6	5.25	7.75
12	10.5	15.5
24	21.0	31.0

135.5 Rain test – 24 volts or less

135.5.1 A recreational vehicle fan of the type specified in 48.1.1 shall be tested as specified in Section 48, Water Spray Tests. If the fan is to be operated during this test, the test voltages shall be in accordance with Table 135.1.

135.6 Vibration test – 24 volts or less

135.6.1 A fan and its mounting means shall withstand vibration without mechanical breakdown that impairs its intended operation. The blower shall operate in its intended manner before and after the test.

135.6.2 The fan is to be secured to the vibration machine test fixture in its intended operating position in accordance with the manufacturer's installation instructions.

135.6.3 The fan is to be subjected to vibration in the horizontal, vertical, and lateral axis orientation for 4 hours in each axis at the resonant frequency of the sample. The resonant frequency is to be determined while varying the frequency from 0 to 60 hertz. The peak-to-peak amplitude is to be 0.508 ±0.003 mm (0.020 ±0.001 inch). When two or more resonant conditions are found, the total test time is to be divided to permit testing at each resonant condition providing no test is maintained for less than 1 hour. When no resonant frequency is determined, the sample is to be tested at 55 hertz.

135.6.4 For these tests, peak-to-peak amplitude is defined as the maximum displacement of sinusoidal motion – total table displacement. Resonant frequency is defined as the maximum magnification of the applied vibration.

136 Manufacturing and Production Tests

136.1 Dielectric voltage-withstand test – 24 volts or less

136.1.1 As a routine production-line test, a recreational vehicle fan shall withstand an applied potential of 500 volts direct current or 355 volts at 60 hertz for 1 minute or 600 volts direct current or 425 volts at 60 hertz for 1 second without electrical breakdown. The potential is to be applied between live- and dead-metal parts. The test is to be conducted as specified in 76.3 – 76.7.

137 Marking

137.1 A recreational vehicle fan shall be marked to indicate the maximum fusing permitted that should not exceed the ampacity of the copper conductors in accordance with Table 137.1.

Table 137.1
Ampacity of conductors

Wire size AWG (mm^2)[a]	Ampacity	Wire type
18 (0.82) or less	6	Stranded only
16 (1.3)	8	Stranded only
14 (2.1)	15	Stranded only
12 (3.3)	20	Stranded only

[a] Minimum wire size used in a fan.

137.2 The lamp trade number designation applicable to a low-voltage circuit (24 volts or less) shall be marked at a point where visible during relamping, in paint-stenciled, self-adhesive label, die-stamped or indelibly stamped capital lettering at least 1.59 mm (1/16 inch) high adjacent to each lampholder. The lamp number designation shall be expressed in the blank space in the following wording which shall include "CAUTION" and the following or equivalent: "To Reduce The Risk Of Fire, Use Lamp Trade Size _____."

FANS FOR AGRICULTURAL BUILDINGS

138 General

138.1 A fan intended for use in a barn, a poultry house, a dairy barn, and the like, as specified in Article 547 of the National Electrical Code, ANSI/NFPA 70, shall comply with the applicable requirements in Part 1 of this Standard and Sections 139 – 141. Also see 5.1.

139 Construction

139.1 An arcing part shall be enclosed in a corrosion-resistant enclosure having no openings and complying with the applicable outdoor use requirements specified in Section 166.

139.2 A totally enclosed motor described in 2.3.19 shall be used in a fan intended to be installed in the locations mentioned in 138.1.

139.3 Where flexibility of interconnecting wiring is required for the application, such as to permit fan adjustment, the wiring shall be installed in liquid-tight flexible metal or non-metallic conduit terminated with liquid-tight flexible metal or non-metallic conduit fittings.

139.4 A power supply cord shall be of the three-conductor hard usage type, minimum SJ or SJT. When the fan is intended to be used outdoors, the power supply cord shall be type SJW or SJTW.

139.5 An equipment-grounding terminal shall be provided. See 35.2.2.

140 Performance

140.1 The temperatures on an exposed surface shall not exceed a 60°C (140°F) rise in a 25°C (77°F) ambient temperature.

141 Marking

141.1 A fan intended to be used in a location mentioned in 138.1 shall be marked "For Use in Agricultural Buildings," or with an equivalent statement.

141.2 A ceiling-suspended agricultural fan that complies with 90.3.1 shall be marked with the following or equivalent: "Do Not Use An Extension Cord With This Fan."

141.3 A fan intended for use outdoors as specified in 139.4 shall be marked "Outdoor Use".

CEILING INSERT FAN/LIGHT COMBINATIONS

142 General

142.1 These requirements cover two types of ceiling insert fan/light combinations, each referred to as a "unit" in Sections 142 – 146. These units, investigated and identified for installation in a cavity where they directly contact thermal insulation, include:

a) A thermally protected Type IC ceiling insert fan/light combination; and

b) An inherently protected Type IC ceiling insert fan/light combination constructed such that, even without a thermal protector, the unit limits temperatures at points in contact with insulation when overlamped in a manner equivalent to that of a thermally protected unit. Additionally, this unit does not depend on the fan motor to meet temperature limits.

142.2 A ceiling insert fan/light combination shall comply with the applicable requirements in Part 1 of this Standard, the requirements of Section 178 – 179A, and with the applicable requirements in Sections 143 – 146.

143 Construction

143.1 A thermally protected Type IC unit shall be provided with thermal protection that cycles the lamp circuit. The protector shall comply with the requirements for devices rated for control of incandescent lamps, as specified in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series.

143.2 A unit that relies on the fan motor for cooling during the Normal Temperature Test described in 144.1.1 – 144.1.11 shall have one of the following features:

a) A thermostat as described in 143.3; or

b) The fan and light factory-wired in parallel such that the connections are inaccessible during inspection and when making field wiring connections.

143.3 An automatic-reset overtemperature-protective device that is provided on a thermally protected Type IC unit to cycle the fan motor on and off, to regulate the temperatures during the Normal Temperature Test, shall comply with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series, including the 100,000 cycle Endurance Test.

144 Performance

144.1 Normal temperature test

144.1.1 A ceiling insert fan/light combination is to be tested at the voltage described in 46.1.10 and with the lamp connected to a separate supply source to yield maximum marked lamp wattage. The test is to be conducted with the unit installed in a box filled with insulation specified in 144.1.6. The test is to be conducted at an ambient temperature of 25 ±5°C (77 ±9°F). The temperatures attained shall not exceed the values specified in Table 46.1.

144.1.2 During the test, a thermal protective device connected in the light circuit shall not cycle (nuisance trip). (See 143.2.)

144.1.3 A ceiling insert fan/light combination is to be mounted in a rectangular box built of 12.7-mm (1/2-inch) thick fir plywood, (a) – (d) grade. The plywood test box is to have dimensions such that each wall is 216 mm (8-1/2 inches) from the nearest point of the recessed housing, junction box, or incidental projection of the unit and the top edge of each wall is 216 mm above the height of the installed unit. The top of the box is to be open. The thickness of the surface of the box representing a ceiling is to be increased as necessary for a unit that is intended for thicker ceilings than 12.7 mm or that is adjustable to accommodate different ceiling thicknesses.

Note: 216 mm (8-1/2 inches) of insulation is equivalent to a total thermal resistance of R32.

144.1.4 A hole is to be provided in the side of the box to permit an exhaust duct or hose of the size recommended in the installation instructions to exit the box. The hose is to be installed parallel to the bottom of the test box and is to be just long enough to reach through the hole. There are to be no bends in the exhaust duct or hose.

144.1.5 When a screen or shield is provided so that insulation does not contact the recessed housing, the plywood test box is to be spaced 216 mm (8-1/2 inches) from the screen or shield. The screen or shield is to be rigidly attached, and of sufficient strength to support the field-installed insulation and to withstand normal handling without reduction of intended spacings.

Exception: The screen or shield is to be removed when it is not attached in a permanent manner such as with rivets, weldings, or a means that requires the use of tools.

144.1.6 The interior space between the plywood box and the exterior surface of the recessed housing is to be filled with loose fill cellulosic insulation or a combination of loose fill cellulosic insulation and rigid polystyrene insulation as specified in 144.1.6A. Loose fill cellulosic insulation is to be rated, conditioned, and placed as specified in 144.1.7 – 144.1.10. Rigid polystyrene insulation is to be specified and installed as specified in 144.1.12.

144.1.6A When using a combination of loose fill cellulosic insulation and rigid polystyrene insulation, the distance between the recessed housing and rigid polystyrene insulation shall be a minimum of 50.8 mm (2 inches). The rigid polystyrene insulation shall be the same height as the box walls and shall be installed lining the box walls with no gaps. The distance between the recessed housing and rigid polystyrene insulation shall be filled with loose fill cellulosic insulation. The top of the recessed housing is to be covered in loose fill cellulosic insulation only. The addition of the total thermal resistance of loose fill

cellulosic insulation plus the total thermal resistance of the rigid polystyrene is equal to or greater than specified in 144.1.3.

144.1.7 The cellulosic insulation is to be rated for a thermal resistance of 3.75 – 3.85 R with a conditioned density of 32.04 – 40.05 kg/m^3 (2.0 – 2.5 pounds per cubic foot).

144.1.8 The insulation is to be conditioned through a blowing or vacuum machine before being placed around the test fixture. The blowing or vacuum machine is to condition the insulation to the density specified in 144.1.7.

144.1.9 Insulation that has been conditioned through a blowing machine can be blown to allow it to fall into the test box around the unit or into a storage container. The insulation conditioned by a blowing machine into a storage container or by the vacuum machine into a storage container is to be placed in the test box around the unit by hand or scoop in a manner to minimize packing or settling.

144.1.10 The insulation is to be placed into the space between the test box and unit in a uniform manner such that all areas surrounding the mounting brackets, incidental projections, and the like, are free of large air pockets or cavities. Small cavities such as 12.7-mm (1/2-inch) high spaces between the brackets and the test box are not required to be filled other than through natural filling as a result of placing the insulation around the area.

144.1.11 The test is to be conducted under each of the following conditions:

a) Fan on – Light on

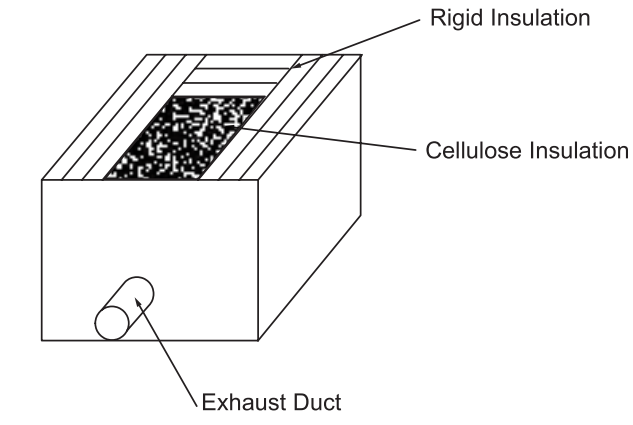
b) Fan off – Light on

Exception: The test is to be conducted only in the Fan on – Light on condition for a fan/light combination constructed in accordance with 143.2(b).

144.1.12 Rigid polystyrene insulation shall be polystyrene and contain no films, coatings, additives with a minimum thickness of 25.4mm (1 inch). Each sheet shall be cut and fitted in to the test box so to minimize air gaps between sheets and joints without compacting the sheet. No adhesives shall be used to secure the insulation. See Figure 144.0.

Figure 144.0

Insulation Box Configuration



144.2 Abnormal operation tests

144.2.1 Inherently protected – overlamping

144.2.1.1 An inherently protected unit connected to a supply as described in 144.1.1 and installed as described in 144.1.3 – 144.1.10 is to be operated with the largest type and wattage lamp that will physically fit into the unit with the trim and diffuser installed and positioned as intended. The test is to be conducted in the "fan off-light on" condition. The temperatures attained on parts of the unit in contact with combustible materials (for example, insulation, the test box, and unit support surfaces) after 7-1/2 hours of operation shall not exceed 90°C (194°F).

Exception: This requirement does not apply to fans having a fluorescent or LED, ANSI GU24 pinbase lampholder and provided with markings relevant to self-ballasted lamp use.

144.2.2 Thermally protected – overlamping

144.2.2.1 A thermally protected unit is to be connected to a supply as described in 144.1.1 and installed as described in 144.1.3 – 144.1.10.

Exception: This requirement does not apply to fans having a fluorescent or LED, ANSI GU24 pinbase lampholder and provided with markings relevant to self-ballasted lamp use.

144.2.2.2 The fan is to be operated with a lamp as specified in Table 144.1.

Table 144.1
Lamp wattage to be used for overlamping test conditions

Lamp type – medium base			
Arbitrary (Type A)			
Rated lamp		Test lamp	
Watts	Size	Watts	Size
40	A19	60	A19
60	A19	75	A19
75	A19	100	A19
100	A19	150	A21
150	A21	200	A23
200	A23	300	PS25
300	PS25	N/A	N/A
Type R reflector lamps			
Rated lamp		Test lamp	
Watts	Type	Watts	Type
30	R20	50	R20
50	R20	75	R30
50	R30	75	R30
75	R30	100	R30
100	R30	150	R40

Table 144.1 Continued on Next Page

Table 144.1 Continued

75	R40	150	R40
150	R40	300	R40
300	R40	N/A	N/A
Type BR reflector lamps			
Rated lamp		**Test lamp**	
Watts	**Type**	**Watts**	**Type**
40	BR30	45	BR30
45	BR30	60	BR30
60	BR30	65	BR30
65	BR30	75	BR30
75	BR30	85	BR30
85	BR30	90	BR40
65	BR40	75	BR40
75	BR40	85	BR40
85	BR40	90	BR40
90	BR40	120	BR40
120	BR40	150	BR40
150	BR40	200	BR40
200	BR40	300	BR40
300	BR40	N/A	N/A
Type ER reflector lamps			
Rated lamp		**Test lamp**	
Watts	**Type**	**Watts**	**Type**
50	ER30	75	ER30
75	ER30	150	ER30
150	ER30	N/A	N/A
Type PAR reflector lamps			
Rated lamp		**Test lamp**	
Watts	**Type**	**Watts**	**Type**
65	PAR38	75	PAR39
75	PAR38	85	PAR38
85	PAR38	150	PAR38
100	PAR38	150	PAR38
150	PAR38	250	PAR38
250	PAR38	N/A	N/A
Type PAR tungsten-halogen reflector lamps			
Rated lamp		**Test lamp**	
Watts	**Type**	**Watts**	**Type**
40	PAR16	60	PAR16
60	PAR16	75	PAR38
50	PAR20	75	PAR30L

Table 144.1 Continued on Next Page

Table 144.1 Continued

60	PAR30S	75	PAR38
50	PAR30L	75	PAR30L
75	PAR30L	90	PAR38
45	PAR38	60	PAR38
60	PAR38	75	PAR38
75	PAR38	90	PAR38
90	PAR38	100	PAR38
100	PAR38	120	PAR38
120	PAR38	N/A	N/A

144.2.2.3 A fan rated for lamps that are not included in Table 144.1 is to be tested with a lamp of the same type used in the normal temperature test that is the next higher common lamp rating.

144.2.2.4 The test is not required to be conducted if the lamp size and type cannot be physically accommodated in the lamp compartment with the trim and diffuser installed and positioned as intended.

144.2.2.5 For a fan that includes a relamp marking allowing more than one lamp type to be used, the overlamping test is to be conducted separately for each lamp type described within the marking.

144.2.2.6 For a fan that includes multiple lampholders, the overlamping test shall be conducted separately for each lampholder. One lampholder at a time, shall use the prescribed test lamp; the remainder of the lampholders shall use bulbs of the rated wattage.

144.2.2.7 The test is to be conducted in the "fan off-light on" condition. For those units provided with a thermostat to cycle the fan motor on and off as described in 143.3, the test is to be conducted with the fan motor out of the circuit.

144.2.2.8 The temperatures attained on parts of the unit in contact with combustible materials (for example, insulation, the test box, and unit support surfaces) after 7-1/2 hours of operation shall not exceed those specified in 144.2.2.9.

144.2.2.9 The supply voltage is to be adjusted to cause the lamp to operate at rated lamp wattage. The unit is to be operated until the thermal protector trips as follows:

a) If the thermal protector operates within 3 hours, the lamp in the unit is to de-energize and temperatures attained on parts of the unit in contact with combustible materials (for example, insulation, the test box, and the unit surfaces) shall not exceed 160°C (320°F).

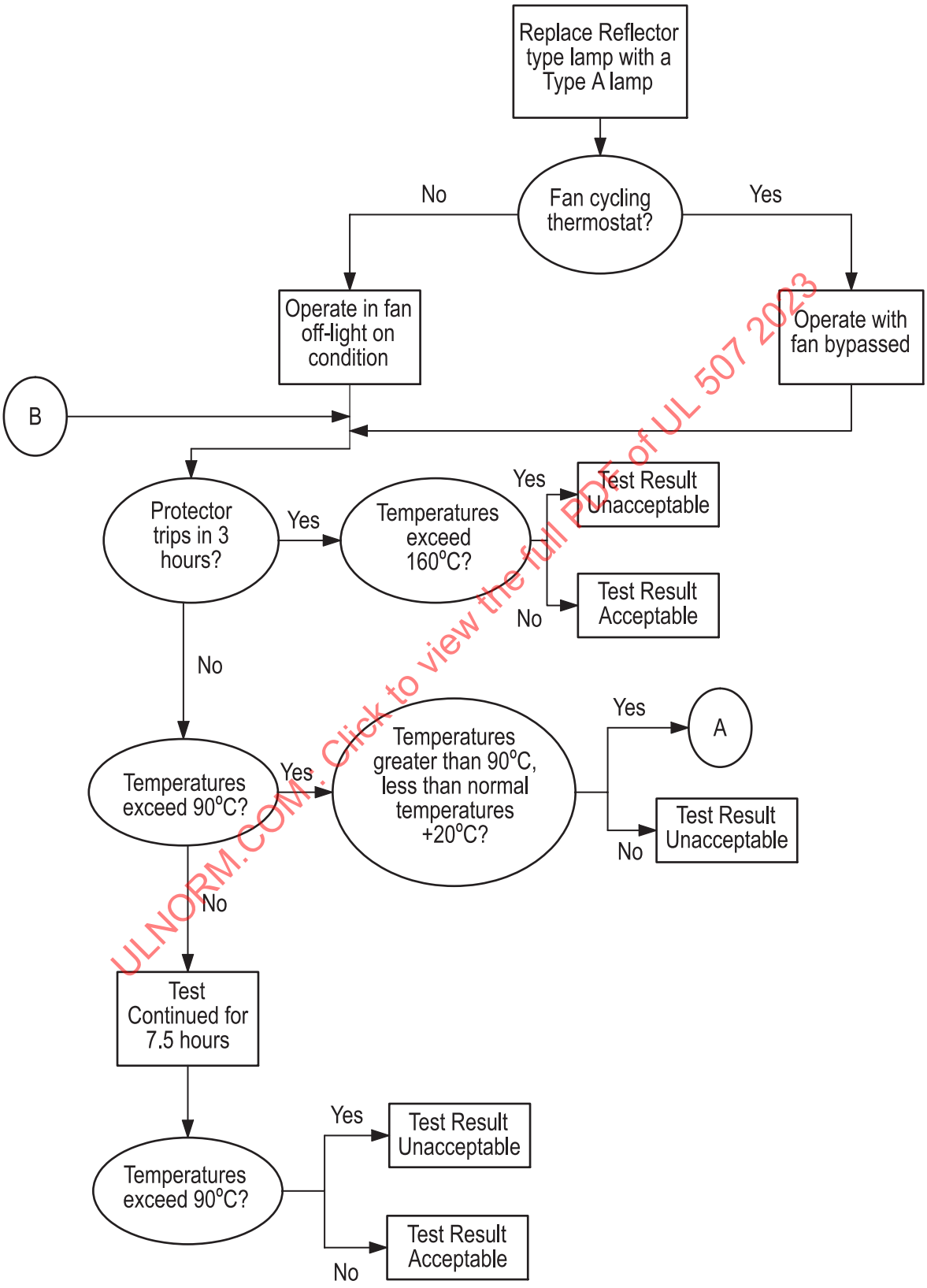
b) If the thermal protector does not operate within 3 hours to de-energize the lamp in the unit, the unit is to continue to operate until the thermal protector operates or for a total of 7-1/2 hours from the start of the test, whichever occurs first. During this time the temperatures attained on parts of the unit in contact with combustible materials shall not exceed 90°C (194°F). If the thermal protector does not operate, the test is then to be reconducted with successively higher lamp wattages (unless the lamp size and type cannot be physically accommodated in the lamp compartment, thus ending the test) as specified in Table 144.1 until the protector operates as described in (a).

144.2.3 Mislamping test

144.2.3.1 A thermally protected unit is to be connected to a supply as described in 144.1.1, installed as described in 144.1.3 – 144.1.10, and tested as described in 144.2.3.2 – 144.2.3.8. See Figure 144.2.

Exception: This requirement does not apply to fans having a fluorescent or LED, ANSI GU24 pinbase lampholder and provided with markings relevant to self-ballasted lamp use.

Figure 144.2



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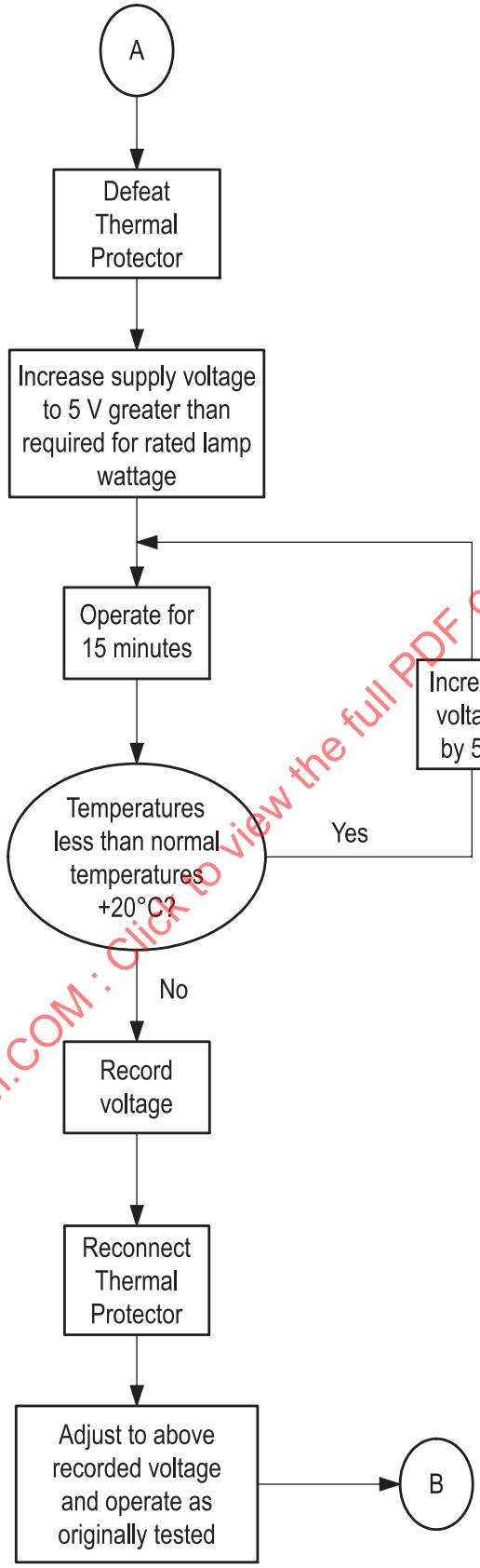

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144.2.3.2 A fan marked for use with a reflector-type lamp shall be tested with a Type A lamp of the same wattage. If the same wattage Type A lamp is not available, use the next higher wattage for Type A lamps as shown in Table 144.1.

144.2.3.3 For a fan that has more than one lamp, the mislamping test shall be conducted separately for each lamp. One lampholder at a time, shall use the prescribed test lamp; the remainder of the lampholders shall use bulbs of the rated wattage.

144.2.3.4 The test is to be conducted in the "fan off-light on" condition. For those units provided with a thermostat to cycle the fan motor on and off as described in 143.3, the test is to be conducted in the fan off – light on condition (with the thermostat permitted to cycle the fan) and then repeated with the fan motor out of the circuit.

144.2.3.5 The test shall be continued until:

a) The thermal protector trips;

b) The temperature limits are exceeded as defined by 144.2.3.6; or

c) 7.5 h has elapsed.

144.2.3.6 If the thermal protector does not open in 3 h and the temperatures on the fan surfaces in contact with thermal insulation and the points of support are more than 90°C, but less than 20°C above the temperatures measured on these same points during the normal temperature test, the test procedure in 144.2.3.7 shall be performed.

144.2.3.7 Perform the following test procedure on a fan that complies with 144.2.3.6 after the fan has reached thermal stabilization:

a) Defeat the thermal protector;

b) Increase the supply voltage to 5 V above that required to make the lamp operate at rated wattage;

c) Operate the fan and measure the temperature of points of the fan in contact with thermal insulation and points of support after 15 min;

d) If the temperatures measured are less than 20°C above the temperature measured at that point during the normal temperature test, return to the point in the procedure described in (b) and raise the supply voltage another 5 V; and

e) When any of the temperatures measured in (c) exceed the temperature measured at that point during the normal temperature test by 20°C:

1) Record the supply voltage;

2) De-energize the fan and let it cool to room ambient temperature;

3) Reconnect the thermal protector;

4) Connect the fan to a supply adjusted to the voltage recorded in (1) and let it operate; and

5) Apply Clauses 144.2.3.5 and 144.2.3.8.

144.2.3.8 Test results shall be acceptable if the thermal protector:

a) Operates within 3 h and the temperature of any part of the fan in contact with thermal insulation or the test box does not exceed 160°C;

b) Does not operate within 3 h, the test is continued for 7.5 h, and the temperature of any part of the fan in contact with thermal insulation or the test box does not exceed 90°C; or

c) Does not operate within 3 h and then complies with (a) or (b) after being subjected to the test of 144.2.3.7.

144.2.4 Thermally protected – defeated fan motor

144.2.4.1 The tests described in 144.2.4.2 – 144.2.4.4 apply to units that rely on the fan motor for cooling during the Normal Temperature Test specified in 144.1.1 – 144.1.11.

144.2.4.2 The unit is to be connected to a supply as described in 144.1.1 and installed as described in 144.1.3 – 144.1.10 except that the fan motor is to be taken out of the circuit.

144.2.4.3 The unit is to be operated at the marked lamp wattage. The thermal protector shall operate within 3 hours, the lamp in the unit shall de-energize, and temperatures attained on parts of the unit in contact with combustible materials (for example, insulation, the test box, and the unit surfaces) shall not exceed 160°C (320°F).

144.2.4.4 The unit is then to be operated according to the underlamping test procedure outlined in Figure 144.1. The test is to be conducted at successively lower lamp wattages (Table 144.2) until one of the following conditions are met when using a lower than rated wattage lamp:

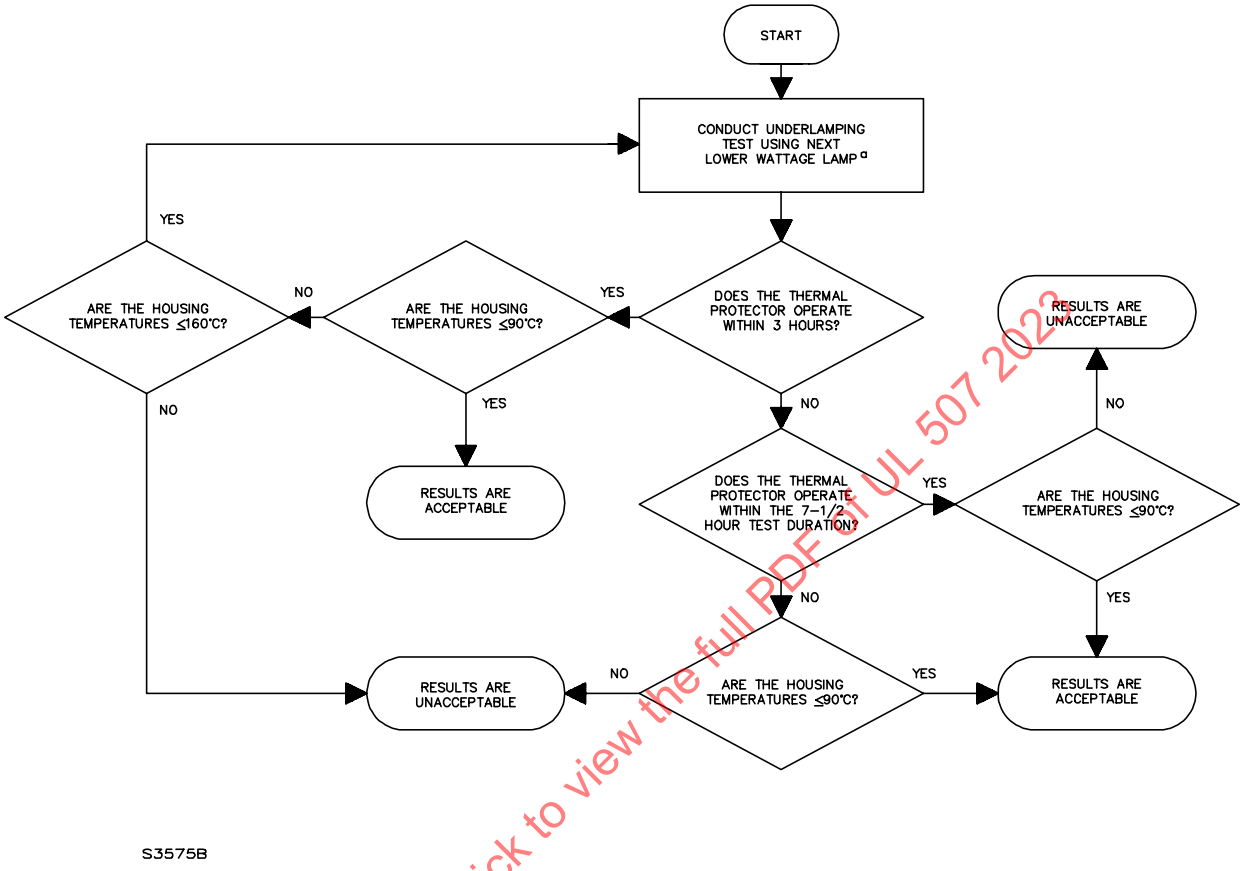
a) The thermal protector operates within 3 hours and temperatures attained on parts of the unit in contact with combustible materials do not exceed 90°C (194°F).

b) The thermal protector does not operate and temperatures attained on parts of the unit in contact with combustible materials do not exceed 90°C (194°F) after a test duration of 7-1/2 hours.

Exception: When the protector operates at the rated lamp wattage before the housing and support temperatures exceed 90°C in 144.2.4.3, the underlamping procedure is not required to be conducted.

Figure 144.1

Flow chart for underlamping test procedure



[a] In accordance with Table 144.2

Table 144.2
Lamp wattage to be used for underlamping test conditions

Arbitrary (Type A)[a]			
Lamp		Test lamp	
Rating	Size	Wattage	Size
200	A23	150	A21
150	A21	100	A19
100	A19	75	A19
75	A19	60	A19
60	A19	40	A19
40	A19	–	–

[a] When other than a Type A lamp is provided, the test lamp shall be as specified for the overlamping test for recessed fixtures in the Standard for Luminaires, UL 1598, except the rated and test lamps are to be taken in reverse order.

144.2.5 Locked rotor

144.2.5.1 A ceiling insert fan/light combination, inherently protected or thermally protected, connected to a supply as described in 144.1.1 and installed as described in 144.1.3 – 144.1.10 is to be operated in the locked-rotor condition with the light on and with a lamp of the maximum rated wattage marked on the unit. There shall be no emission of flame or molten metal after 7-1/2 hours of operation. An impedance-protected motor shall also comply with the locked-rotor temperature requirements specified in 50.5.

145 Marking

145.1 A Type IC unit that complies with the requirements in 144.1.1 – 144.2.1.1 and 144.2.5.1 shall be marked where visible during and after installation "TYPE IC – INHERENTLY PROTECTED."

145.2 A Type IC unit that complies with the requirements in 144.1.1 – 144.1.11 and 144.2.2.1 – 144.2.5.1 shall be marked where visible during and after installation "TYPE IC – THERMALLY PROTECTED."

145.3 A thermally protected Type IC unit shall be marked at a point where visible during relamping "NOTICE – Blinking light may indicate: (improper lamp wattage or type, fan malfunction, or other condition causing overheating)." Conditions which result in the light blinking shall be stated in place of the phrase provided in parentheses.

145.4 A thermally protected Type IC unit provided with the device described in 143.3 to cycle the fan motor on and off to regulate the temperatures during the Normal Temperature Test shall be marked at a point where visible during relamping "NOTICE – Fan is intended to cycle when the light is on," or equivalent wording.

145.5 A ceiling insert fan/light combination shall be marked where readily visible during relamping with "CAUTION – RISK OF FIRE" and the following or equivalent wording: "For Usage Other Than Tub or Shower: Type _____ MAX ___W, or _____MAX ___W LAMP(S)" The marked watts shall be no greater than the lamp wattage used in the normal temperature test described in Section 144. The use of the expressions in parentheses in the marking is optional.

Exception: When the fan is not intended to be used in a tub or shower area, the marking "For Usage Other Than Tub or Shower" is not required.

146 Operating and Installation Instructions

146.1 A ceiling insert fan/light combination with an automatic-reset overtemperature device as specified in 143.3 shall be provided with instructions that indicate that the fan is intended to cycle on and off to maintain normal operating temperatures.

SWAG-MOUNTED CEILING-SUSPENDED FANS

147 General

147.1 A portable fan intended for suspension from the ceiling by a down rod and provided with a metal chain and a flexible cord for connection to a power supply shall comply with the applicable requirements in Part 1 of this Standard, the requirements of Sections 89 – 93, and with the requirements in Sections 148 – 150. When there is conflict between the requirements in Sections 148 – 150 and those in Part 1 and Sections 89 – 93, the requirements in Sections 148 – 150 shall apply to a swag fan.

148 Construction

148.1 The total length of chain shall be not less than 3.05 m (10 feet) nor more than 6.1 m (20 feet), and shall not support the fan.

148.2 The weight of a fan with any intended combination of accessories installed shall not exceed 23 kg (50 pounds).

148.3 The 23-kg (50-pound) weight limitation referred to in 148.2 shall be determined as specified in 148.4 for fans or accessories that are intended to support objects other than the fan or accessory.

148.4 With reference to the weight specification in 148.3, a fan or fan accessory that is provided with a bowl, a shelf, or a hook intended for the support of any object that is not part of the fan or fan accessory itself shall be investigated to determine the total possible weight of the installed fan, accessory, and anticipated additional loading. It is not possible to specify the conditions of possible loading of all constructions; however, the most severe conditions of anticipated use and abuse shall be considered – for example, a bowl is to be filled to capacity with dry sand and additionally filled with water.

148.5 The flexible power-supply cord of the fan shall:

a) Extend not less than 0.305 m (1 foot) or more than 0.91 m (3 feet) beyond the end of the chain;

b) Be not smaller than 18 AWG (0.82 mm^2);

c) Have a temperature rating acceptable for the application, as determined for all fans by the maximum temperature achieved during the Temperature Test, Section 46; and

d) Be:

1) Type SPT-1 and provided with a separate jacket of nylon or the equivalent; or

2) Type SPT-2 or heavier cord.

148.6 When a metallic fan housing serves as the enclosure for internal wiring and splices, such wiring and splices shall be provided with supplementary insulation, rated for the temperature involved, or means shall be provided that keep the wiring from contacting the metal housing.

Exception: This requirement does not apply to a fan provided with a cord employing an equipment-grounding conductor.

148.7 The supplementary insulation mentioned in 148.6 may consist of woven-glass tape, close-fitting woven-glass sleeving, insulating tape or tubing not less than 0.25 mm (0.01 inch) thick.

148.8 Flexible cord that has had the outer jacket removed is regarded as internal wiring and is to be judged under the requirements in 148.6.

148.9 When a lampholder is provided, it shall have a body of insulating material.

Exception: This requirement does not apply to a fan provided with a cord employing an equipment-grounding conductor.

148.10 When the insulation body of a lampholder is provided with a metal nipple or tube fitting in an opening in the body wall, the inner end of the nipple or tube shall not extend inward beyond the inner surface of the lampholder body.

148.11 Polymeric insulating material used to separate dead metal parts of a lampholder or switch from a metal fan housing or chain support shall be acceptable for the temperature involved. An insulating material other than polymeric shall be investigated for the acceptability for the application.

148.12 The minimum spacings through air or over the surface between the dead metal parts of a lampholder or a switch and the metal of the fan housing or the chain support shall be not less than 1.2 mm (3/64 inch), except that a through-cord switch having exposed dead metal parts shall be located at least 38.1 mm (1-1/2 inches) from any part of the chain or metal fan housing.

Exception: A through-cord switch having exposed dead metal parts may be located less than 38.1 mm from the metal of the fan housing or chain support when the fan is provided with a cord employing an equipment-grounding conductor.

148.13 A swag-mounted ceiling-suspended fan shall include an equipment grounding conductor.

Exception: A swag-mounted fan is not required to include an equipment grounding conductor when the fan is marked as specified in 149.1 and the installation instructions comply with 150.2.

149 Marking

149.1 A swag-mounted fan that is not grounded shall be marked to indicate that it is not to be installed in a bathroom or kitchen.

150 Installation Instructions

150.1 Installation instructions shall be provided with each fan and shall include the following:

a) Clear instructions for the use of hardware provided;

b) A statement that installation shall be on a joist and shall not be on a radiant-heating ceiling, nor accomplished by means of a toggle bolt; and

c) A caution that hooks should engage the chain only and not the electric cord.

150.2 Installation instructions for a swag-mounted fan that is not grounded shall warn against mounting in a bathroom or kitchen. See 149.1.

151 Swag Kits

151.1 A fan to be used with a swag kit, and the swag kit, shall comply with the requirements in 147.1 – 150.1 and 151.2 – 151.6.

151.2 When strain relief is provided by the manufacturer, it shall be factory installed. Any other means such as tying a knot in a cord shall comply with the requirements specified in 151.4 and Section 54, Strain Relief Test.

151.3 All component parts of the swag kit shall be provided with the kit.

Exception No. 1: Small parts commonly available for the mounting of the fan to be used with the swag kit are not required to be provided when instructions for intended mounting that refer to such parts are furnished in accordance with 150.1.

Exception No. 2: Parts such as a ceiling canopy that are provided and shipped with the fan are not required to be provided with the swag kit.

151.4 As part of the investigation, a kit shall be tested and trial-installed to determine that installation is feasible, that the instructions are detailed and correct, and that the use of the kit does not introduce a risk of fire or injury to persons.

151.5 Each splice enclosure contained in the kit shall comply with the applicable enclosure requirements specified in Section 7, Frame and Enclosure.

151.6 A swag kit shall be marked to include the name of the manufacturer and the model number of the fan that is to be used with the swag kit.

152 Through-Cord In-Line Speed Controllers

152.1 General

152.1.1 An in-line speed controller provided with a ceiling-suspended cord-connected fan shall comply with the applicable requirements in Part 1 of the Standard, Sections 89 – 93, and the requirements specified in 152.2.1 – 152.4.2. The combination shall comply with the applicable requirements in Part 1 of the Standard and Sections 89 – 93.

152.2 Construction

152.2.1 A controller shall be provided with an enclosure that complies with the requirements for Frame and Enclosure, Section 7.

152.2.2 A controller shall be provided with an enclosure that has a mounting means consisting of a separate mounting bracket, an exposed ring hanger, or concealed keyhole slots for mounting on the wall. The mounting means shall comply with the following:

a) A mounting bracket shall not contain any wiring or project more than 12.7 mm (1/2 inch) from the wall. A mounting bracket and the enclosure shall be constructed so that the speed controller cannot readily be permanently mounted to the mounting bracket or mounted directly to the wall without the use of the bracket.

b) An exposed ring hanger shall have a diameter of at least 12.7 mm (1/2 inch).

c) Concealed keyhole slots shall be located so that supporting screws and the like cannot damage the insulation on wiring or contact uninsulated live parts of the speed controller.

152.2.3 The controller shall be provided with the mounting means – such as brackets and screws – required to mount the controller in place as intended. Hardware shall be provided to route the cord connected between the controller and the fan along wall and ceiling surfaces. Such hardware shall:

a) Be non-metallic;

b) Be packaged with the controller; and

c) Not encircle the cord.

Surfaces of the hardware that contact the installed cord shall be smooth.

152.2.4 A controller shall be rated for the load it controls. All internal current-carrying parts (switches, choke coils, solid state circuits, and the like) shall comply with the requirements for those components.

152.2.5 A controller shall be provided with a 1.5 – 3.05 m (5 – 10 foot) length of power-supply cord. The power-supply cord and the wiring from the controller to the fan shall be Type SP-2 or heavier, 18 AWG (0.82 mm^2) or larger, and shall have a 4.6 – 6.1 m (15 – 20 foot) length.

152.2.6 Strain relief shall be provided for the power-supply cord where it enters the controller and for both ends of the wiring from the controller to the fan. The completed installation shall comply with the requirements for Strain Relief in Section 54.

152.2.7 The material of a controller part (such as an enclosure, frame, or guard), the breakage of which results in a risk of injury to persons, shall have properties that meet the demand of expected use conditions.

152.2.8 The requirement in 152.2.7 applies to those portions of a part adjacent to moving parts determined to involve a risk of injury to persons.

152.3 Performance

152.3.1 After a controller part as specified in 152.2.7 is subjected to the applicable impact test described in 152.3.2 – 152.3.4:

a) The controller shall not be damaged so as to introduce a risk of injury;

b) Parts of the controller capable of causing electric shock or risk of injury to persons shall not be exposed to unintentional contact, as determined by application of the accessibility probes as specified in the accessibility of live part requirements in Section 10;

c) The controller shall remain intact with all parts in their original position; and

d) The controller shall comply with the Dielectric Voltage-Withstand Test, Section 47.

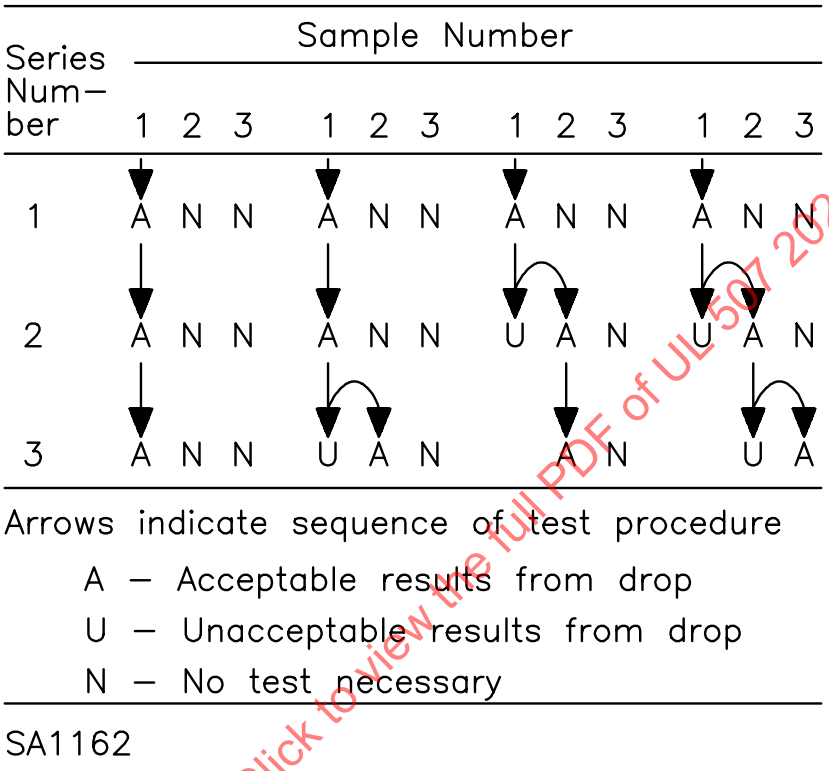
152.3.2 A speed controller is to be dropped three times from a height of 1.5 m (5 feet) onto the hardwood surface described in 70.3. Each of the drops is to cause the controller to impact the surface at a different controller enclosure location.

152.3.3 Three samples are to be prepared for the test; however, depending on test results, fewer samples may be tested in accordance with Figure 152.1. The test result is acceptable upon completion of

any one of the arrow paths represented. When any tested sample does not comply with 152.3.1 after its first series of three drops, the results of the test are unacceptable.

Figure 152.1

Impact test procedure



152.3.4 A product is to be subjected to the test with or without any attachment recommended by the manufacturer so as to result in the most severe test.

152.3.5 The controller shall remain in place and all parts remain intact and in their original position during the following test. The controller is to be mounted on nominal 9.52-mm (3/8-inch) thick wallboard in accordance with the instructions and mounting hardware provided. Each of the adjustment knobs provided is to be operated 50 times. Each operation is to cause the adjustment to go through its full range of settings when continuous or to each of its settings if a step control, and then back to the initial setting.

152.3.6 The controller shall be compatible with the motor it controls. Abnormal operation including open or shorted components shall not result in a motor exceeding the temperature limits in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and either the Standard for Impedance Protected Motors, UL 1004-2, the Standard for Thermally Protected Motors, UL 1004-3, or the Standard for Electronically Protected Motors, UL 1004-7, as applicable.

152.3.7 As part of the investigation, the controller is to be trial-installed and shall conform with the requirement in 151.4.

152.4 Marking

152.4.1 The controller shall be marked with a model or catalog number and it shall also be marked to identify the intended compatible fan model number(s) or the fan series number(s).

152.4.2 Installation instructions shall be provided with each in-line controller that describe the intended mounting and wiring of the controller. The instructions shall cover controller use with a swag-mounted fan in accordance with the requirements in Section 150, Installation Instructions.

FANS FOR USE IN WINDOWS

153 General

153.1 In addition to the applicable requirements in Part 1 and Sections 154 and 155 of this Standard, the non-metallic enclosure or guard of a fan intended for use in a window shall comply with the requirements for Outdoor Use Equipment in 167.3, Exposure to sunlight (ultraviolet radiation). These requirements also address box fans intended for use in windows. Also see 5.1.

154 Construction

154.1 When a fan for use in a window is provided with mounting hardware, the hardware shall retain the fan in position during and after installation in accordance with the manufacturer's installation instructions.

155 Installation Instructions

155.1 Detailed installation instructions with illustrations shall be provided with all box fans intended for installation in windows. The instructions shall also include the size of the window sashes and sills that are appropriate for that particular fan.

TOILET-BOWL FANS

156 General

156.1 A toilet-bowl fan shall comply with the applicable requirements in Part 1 of this Standard and with the applicable requirements in Section 157.

157 Performance

157.1 Water spray test

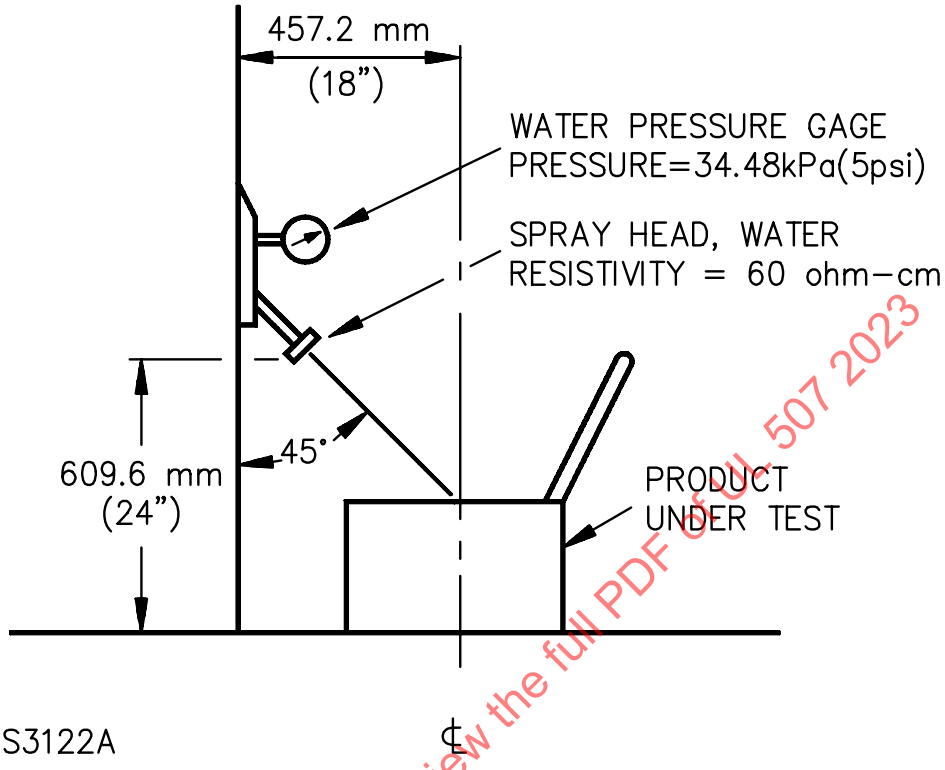
157.1.1 A toilet-bowl fan, when tested as described in 157.1.2 and 157.1.3, shall comply with the requirements in 48.5.1 and 48.6.1 for other than 120 V cord-connected units and in 48.4.2 – 48.4.6 and 48.6.1 for 120 V cord-connected units.

157.1.2 The stationary intake collar of a toilet-bowl fan is to be mounted to a frame intended to simulate the rim of a bathroom toilet-bowl. A toilet-bowl seat is then to be placed as intended over the simulated rim. A single sprinkler head employing the spray head illustrated in Figure 48.1 is to be located under the simulated toilet-bowl rim facing the intake collar. With the fan operating at rated voltage and the sprinkler adjusted to produce 34.48 kPa (5 psi) of water pressure, the intake opening is to be positioned so as to contact the top of the arc of the spray with the spray head in a 45 degree angle. The spray is to be maintained for 1 hour, using water having a resistivity of 60 ±5 ohm-cm.

157.1.3 The toilet-bowl fan is then to be installed as specified in 157.1.2, except that the spray head is to be located above the test assembly as illustrated in Figure 157.1. The toilet-bowl fan is to be exposed to four 1-minute applications of the water spray with a 1-minute interval between applications. The test water solution is to be as specified in 157.1.2.

Figure 157.1

Set-up for water spray test



157.2 Overflow test

157.2.1 When tested as described in 157.2.3, the leakage current of a cord-connected toilet-bowl fan, measured in accordance with 48.4.2, shall not exceed:

a) 2.5 milliamperes during the 30 minutes of overflow;

b) 2.5 milliamperes upon cessation of the overflow; and

c) 0.5 milliamperes 30 minutes after cessation of the overflow.

Within one minute following the leakage current measurement 30 minutes after the cessation of the overflow, the fan shall be tested and shall comply with the Dielectric Voltage-Withstand Test of Section 47.

157.2.2 When tested as described in 157.2.3, the insulation resistance of a permanently installed toilet-bowl fan, measured upon cessation of the overflow, shall be a minimum of 50,000 ohms. Thirty minutes after cessation of the overflow, the fan shall comply with the Dielectric Voltage-Withstand Test of Section 47.

157.2.3 A toilet-bowl fan is to be mounted as intended on a test fixture to simulate a bathroom toilet-bowl. With the fan connected to rated voltage and operating in the intended manner, the toilet-bowl is to be allowed to overflow for a period of 30 minutes. At the beginning of overflow, the water resistivity is to be 60 ±5 ohm-cm. The resistivity of the water is to be increased in approximately equal increments to 3500 ±300 ohm-cm in three 5-minute intervals, and the balance of the test conducted at the maximum water resistivity value.

157.3 Creep test

157.3.1 The requirements in 157.3.2 and 157.4.1 apply only to a thermoplastic enclosure to which a motor, a wiring compartment, or the like is secured by screws such that the material is under load.

157.3.2 Three samples of the enclosure are to be tested. Each screw is to be torqued to 6 pound-inches (0.678 N·m) and the samples are to be placed in an oven maintained at a temperature of 90 ±2°C (194 ±3.6°F) for a period of 300 hours. The samples are then to be removed from the oven and allowed to cool to room temperature of 23 ±2°C (73.4 ±3.6°F). The tightness of each screw is to be determined by measuring the torque required to just turn the screw clockwise (tightening). This torque value is to be no less than 0.339 N·m (3 lb-in).

157.4 Heat cycling test

157.4.1 Three samples of the enclosure are to be tested. Each screw is to be torqued to 0.678 N·m (6 lb-in) and the samples are to be placed in an oven maintained at a temperature of 90 ±2°C (194 ±3.6°F) for 4 hours, followed by 4 hours at a room temperature of 23 ±2°C (73.3 ±3.6°F). This cycling procedure is to be repeated for a total of 304 hours. The tightness of the screws is to be determined as described in 157.3.2. The torque value is to be no less than 0.339 N·m (3 lb-in).

157.5 Temperature cycling tests

157.5.1 Three samples of a toilet-bowl fan having a non-metallic enclosure are to be placed in an environmental chamber maintained at a temperature of 90 ±2°C (194 ±3.6°F) for 1 hour, followed by 1 hour at room ambient, 23 ±2°C (73.4 ±3.6°F), followed by 1 hour at 0.0 ±2°C (32 ±3.6°F). This procedure is to be repeated for a total of three cycles. At the end of this cycling, the non-metallic enclosure shall show no evidence of cracking or distortion or other condition that affects the integrity of the enclosure to the degree that mechanical protection is not afforded to internal parts of the fan.

157.6 Static load test

157.6.1 With the toilet-bowl fan mounted as intended to the toilet-bowl, a static load of 136 kg (300 pounds) is to be applied on the toilet-bowl seat and maintained for a period of 1 minute. The results are acceptable when:

a) The fan remains secured as originally installed; and

b) There is no breakage or cracking of the fan enclosure or other parts that increases the risk of fire, electric shock, or injury to persons.

EVAPORATIVE COOLERS

158 General

158.1 An evaporative cooler that incorporates a heating element is investigated in accordance with the applicable requirements of this Standard and with the applicable requirements for the heating function as used in the overall product:

a) The Standard for Movable and Wall- or Ceiling-Hung Electric Room Heaters, UL 1278, for evaporative cooler that may also function as a room heater.

b) The Standard for Fixed and Location-Dedicated Electric Room Heaters, UL 2021, for an evaporative cooler that may also function as a fixed or dedicated location room heater.

c) The Standard for Electric Heating Appliances, UL 499, for an evaporative cooler with a heating element not addressed by (a) or (b) above.

159 Construction

159.1 Frame and enclosure

159.1.1 With reference to 10.3.1, the filter or filters of an evaporative cooler are 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.

159.2 Motors and pumps

159.2.1 All required motors and pumps shall be provided with an evaporative cooler. They shall be factory installed, shipped in the same carton as the cooler, or shipped in a separate carton and marked as specified in 80.4.1. When a pump or motor is not factory installed, the installation instructions shall include statements specified in 83.9. All motors and pumps intended to be installed in the field shall have provision for field wiring in accordance with the National Electrical Code, ANSI/NFPA 70, or shall be provided with factory installed power supply cords for plug and receptacle connection.

159.2.2 Electrically operated pumps used to circulate water through the filter media of an evaporative cooler or to periodically drain mineral-laden water from the water storage reservoir shall comply with the requirements in the Standard for Motor Operated Water Pumps, UL 778.

Exception No. 1: This requirement does not apply to cord-connected pumps that comply with the Exceptions in Section 204, Construction.

Exception No. 2: This requirement does not apply to permanently-connected pumps that comply with Exception No. 1, 4, 5, and 7 in Section 204, Construction.

159.2.3 An evaporative cooler employing one or more pumps intended to be protected by GFCI protection per 204.1 Exception No. 2(b) shall provide appropriate GFCI receptacles as part of the cooler.

Exception: An internal GFCI receptacle is not required when the evaporative cooler is plainly marked as required in 161.1.

159.2.4 The electronic circuitry provided as part of a drain pump shall comply with the requirements in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series.

159.3 Filters

159.3.1 An evaporative cooler intended to be connected to a duct system that interconnects rooms or spaces within buildings for distributing the moist air shall use a filter that complies with the Standard for Air Filter Units, UL 900. The use of short ducts intended to bring moist air from the equipment, without connection to a duct system within the building, does not necessitate the use of a UL 900 filter.

159.4 Backflow prevention

159.4.1 An air gap shall be provided to prevent backflow from the storage reservoir of an evaporative cooler into a water supply system.

159.4.2 An air-gap fitting shall be constructed so that an unobstructed vertical distance of at least 25.4 mm (1 inch) or of two inlet-pipe inside diameters, whichever is greater, is permanently maintained through the free atmosphere between the lowest opening of the water-inlet device supplying water to the evaporative cooler and the flood-level rim of the reservoir receiving the water.

159.4.3 All parts of the potable water-supply assembly of an evaporative cooler that are in contact with the water, through the discharge terminal point of the air-gap fitting, shall be constructed of nontoxic and corrosion-resistant materials.

159.5 Wetting of live parts

159.5.1 The water reservoir in an evaporative cooler intended for connection to a plumbing system or a garden hose shall be constructed and located so that overflow will not wet insulated or uninsulated live parts or film coated wire, other than motor windings, and there shall be no accumulation of water inside the enclosure. An Overflow test, 160.6, is to be conducted if it is not evident that the evaporative cooler complies with this requirement.

159.5.2 An evaporative cooler with a manually filled water reservoir shall be constructed so that a liquid spill during any likely filling operation will not wet insulated or uninsulated live parts or film coated wire, other than motor windings, and there shall be no accumulation of water inside the enclosure. A Spill test, 160.7, is to be conducted if it is not evident that the evaporative cooler complies with this requirement.

160 Performance

160.1 Input test

160.1.1 The Input Test of Section 45 shall be conducted on an evaporative cooler:

a) With the cooler dry; and

b) When it is using water in the intended manner.

160.2 Temperature test

160.2.1 The Temperature Test of Section 46 shall be conducted on all evaporative coolers with the cooler dry.

160.2.2 The Temperature Test of Section 46 shall also be conducted on an evaporative cooler employing a mechanical pump driven by the fan or blower motor when the cooler is using water in the intended manner.

160.3 Moisture resistance test

160.3.1 When tested under the conditions described in 160.3.2, an evaporative cooler in which the electrical insulation is exposed to the moisture-laden air shall comply with the following:

a) A cord-connected appliance rated for a nominal 120-volt supply shall comply with the requirements in 41.1 in a repeat leakage current test, except that the test is to be discontinued when the leakage current stabilizes.

b) An appliance, other than specified in (a), shall have an insulation resistance of 50,000 ohms or more between live parts and interconnected dead-metal parts.

c) An appliance shall withstand without breakdown for 1 minute the application of a 60-hertz essentially sinusoidal potential of 1000 volts between live parts and interconnected dead-metal parts.

160.3.2 The evaporative cooler is to be operated for 24 hours in cycles of 15 minutes "on" and 45 minutes "off", with water circulating through it in the intended manner. Measurement of the insulation resistance or leakage current and the application of the test potential are to be made immediately upon conclusion of the final on cycle of the 24-hour period.

160.4 Stability test

160.4.1 An evaporative cooler shall not tip over when tested in accordance with the Stability Test in Section 72.

160.5 Ultraviolet light and water exposure

160.5.1 A polymeric material used for the enclosure of an evaporative cooler intended for outdoor or window installation shall comply with the ultraviolet light exposure requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, including flammability, strength, and impact criteria.

Exception: This test is not required if the polymeric enclosure materials comply with UL 746C for outdoor exposure and UV exposure.

160.5.2 A polymeric material used for the enclosure of an evaporative cooler intended for outdoor installation shall comply with the water exposure and immersion requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, including flammability, strength, impact, and dimensional change criteria.

160.6 Overflow test

160.6.1 To determine whether failure to shut off the water supply manually or malfunction or breakdown of a float- or pressure-operated switch, timer switch, or the like will result in a risk of electric shock, the product will be conditioned as described in 160.6.2 and 160.6.3. Compliance with the overflow test shall be determined by:

a) A visual inspection to determine that there is no wetting of uninsulated live parts or film-coated wire, other than motor windings, and no accumulation of water in an electrical enclosure. The accumulation of water droplets shall only be acceptable when the fan complies with the tests in (b) and (c). A drain hole may be provided to reduce the accumulation of water above a level that results in the wetting of an electrical part, or water in an electrical enclosure.

b) A leakage current test for 120 volt cord connected appliances (see 48.4.1 – 48.4.6) or an insulation resistance test for all other appliances (see 48.5.1).

c) A dielectric voltage withstand test (see 48.6.1).

160.6.2 The product shall be connected to a water supply as intended.

a) With any provided timer switch functioning as intended, a provided float- or pressure-operated fill switch shall be defeated and the product started. The fill shall be continued for an additional 15 minutes following the first evidence of overflow of the reservoir. If a timer switch is provided, it should be allowed to cycle as intended for the duration of the test and the test shall be continued for 7 hours.

b) A timer switch, if provided, shall be defeated and the product started. If no automatic shutoff means is provided, the fill shall be continued for an additional 15 minutes following the first evidence of overflow of the reservoir. If a float- or pressure-operated switch is provided as an automatic shutoff means, actuation of the fill switch to terminate the fill will also terminate the test.

c) If both a timer switch and a float- or pressure-operated fill switch are provided, the devices shall each be defeated independently as described above.

d) If the product is not provided with a timer or a float- or pressure-operated fill switch; that is, the water source is intended to be controlled manually, the product shall be started and the fill shall be continued for an additional 15 minutes following the first evidence of overflow of the reservoir.

160.6.3 A rubber barrier or rim seal of a reservoir shall not be removed when a test is being conducted to simulate malfunction or breakdown of a timer switch or of a float- or pressure-operated switch.

160.7 Spill test

160.7.1 When required by 159.5.2, the evaporative cooler is to be positioned as intended in use. The water reservoir is to be filled to capacity with water and then an additional four hundred-forty-four milliliters (15 oz) of water are to be poured into the reservoir at a rate of approximately 30 mL/s (1 oz per second).

160.7.2 Compliance with 159.5.2 shall be determined within 30 minutes after the water is poured into the reservoir by:

a) A visual inspection to determine that there is no wetting of uninsulated live parts or film-coated wire, other than motor windings, and no accumulation of water in an electrical enclosure. The accumulation of water droplets shall only be acceptable when the fan complies with the tests in (b) and (c). A drain hole may be provided to reduce the accumulation of water above a level that results in the wetting of an electrical part, or water in an electrical enclosure.

b) A leakage current test for 120 volt cord connected appliances (see 48.4.1 – 48.4.6) or an insulation resistance test for all other appliances (see 48.5.1).

c) A dielectric voltage withstand test (see 48.6.1).

160.8 Static loading test

160.8.1 A window-type or through-wall-type evaporative cooler shall withstand the test described in 160.8.2 – 160.8.4 without collapse of the cabinet, base, or the supporting means, and shall not fall out of the test window.

Exception: Window-type or through-wall-type units protruding less than 10 inch (254 mm) from the building structure need not undergo this test.

160.8.2 The unit is to be installed in a simulated window frame in accordance with the manufacturer's instructions and with the mounting hardware supplied by the manufacturer, including any brackets or bracing intended to support the rear edge of the unit. The water reservoir shall be filled with the maximum amount of water allowed by the construction of the unit. A load of 200 – 400 pounds-mass (90.5 – 181 kg) per Table 160.1 acting vertically downward shall be applied along the edge parallel with and farthest from the plane of the window.

Exception: If the installation instructions indicate that the unit is intended only for through-wall application, a wall opening as specified by the installation instructions may be used in lieu of the simulated window frame.

Table 160.1
Required static load

Protrusion from building structure		Static load	
Inches	(cm)	pounds-mass	(kg)
≥ 10 and <12	(≥ 25.4 and <30.5)	200	(90.5)
≥ 12 and <14	(≥ 30.5 and <35.6)	220	(99.6)
≥ 14 and <16	(≥ 35.6 and <40.6)	240	(108.6)
≥ 16 and <18	(≥ 40.6 and <45.7)	260	(117.7)
≥ 18 and <20	(≥ 45.7 and <50.8)	280	(126.7)
≥ 20 and <22	(≥ 50.8 and <55.9)	300	(135.8)
≥ 22 and <24	(≥ 55.9 and <61)	320	(144.8)
≥ 24 and <26	(≥ 61 and <66)	340	(153.9)
≥ 26 and <28	(≥ 66 and <71.1)	360	(162.9)
≥ 28 and <30	(≥ 71.1 and <76.2)	380	(172)
≥ 30	(≥ 76.2)	400	(181)

160.8.3 The window shall be mounted in a 4-1/2 inch (114 mm) thick wall and is to be a conventional double-hung type, each sash measuring 32 inches (813 mm) wide by 28 inches (711 mm) high by 1-3/8 inch (35 mm) thick. The window frame is to be 62 inches (1.57 m) high by 36 inches (0.914 m) wide, and is to be provided with a 1-1/2 by 5-1/2 inch (38 by 140 mm) sill, a 3/4 by 3-1/2 inch (19 by 89 mm) stool, and 1/2 by 1-3/8 inch (12.7 by 35 mm) stops. The material used for the frame, sash, sill, stool, and stops is to be No. 1 clear ponderosa pine. The sill shall extend 1/2 inch (12.7 mm) beyond the inside and outside surfaces of the wall.

160.8.4 In this test, a 5 inch (127 mm) wide channel or equivalent is to be placed flat across the top of the outer enclosure of the unit with one edge of the channel flush with the outer edge of the enclosure. Equal weights are to be suspended on wire ropes attached to the center of the channel on either side of the unit. The total load of 400 pounds-mass (181 kg) includes weights, channel, and ropes.

161 Marking

161.1 An evaporative cooler complying with the Exception to 159.2.3 shall be marked "CAUTION" and the following or the equivalent: "To Reduce The Risk Of Electric Shock, Connect Only To An Outlet Provided With A Ground Fault Circuit Interrupting Device."

161.2 The marking in 161.1 shall not be prohibited on evaporative coolers not otherwise required to be so marked.

FLOOR INSERT FANS

162 General

162.1 In addition to the applicable requirements in Part 1 of this Standard, a floor insert fan shall comply with the requirements in Sections 163 and 164. Also see 5.1.

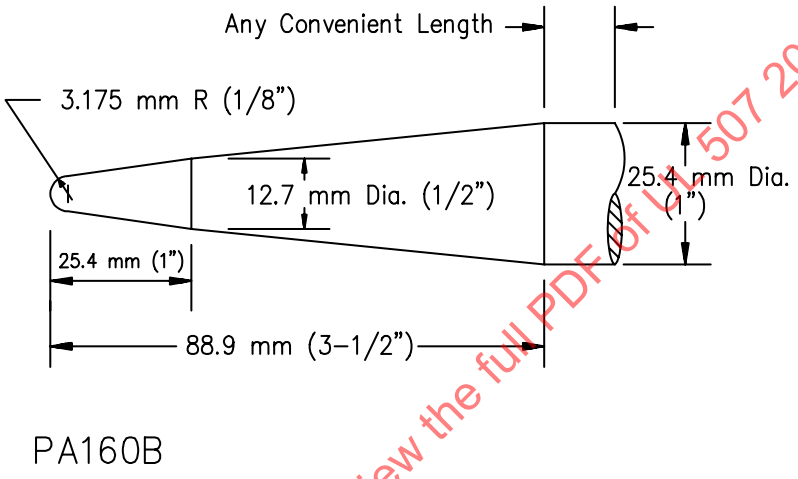
163 Construction

163.1 Moving parts

163.1.1 A moving part (blower wheel) of a floor insert fan that results in a risk of injury to persons shall be guarded so that the probe illustrated in Figure 163.1 does not touch the part when inserted with a force of 4.45 N (1 pound) through any opening in the guard.

Figure 163.1

Probe for moving parts of floor insert fans



164 Performance

164.1 Water splash test

164.1.1 There shall be no dielectric breakdown of a floor insert fan as a result of the test specified in 164.1.2. The insulation resistance shall be at least 50,000 ohms.

164.1.2 A cotton mop, which has been completely immersed in a pail of water for at least 5 minutes, is to be immediately upon removal from the pail swabbed across the floor insert fan's grill five times with the fan de-energized. Within one minute after the last swabbing operation, the insulation resistance measurement and dielectric voltage withstand tests in Section 47 are to be performed.

164.2 Crush test

164.2.1 A floor insert fan shall sustain a 1779 N (400 pound) load applied over a square foot area for 1 minute over the top exhaust grille of the fan, without:

a) Damage to the speed control; and

b) Breakage or cracking of the enclosure or guard, after which the probe illustrated in Figure 163.1 shall not contact a portion of a moving part that results in a risk of injury to persons when inserted through any opening in the guard or enclosure.

OUTDOOR USE EQUIPMENT

165 General

165.1 The requirements in Sections 166 – 169 supplement and, in some cases, modify the general requirements in Part 1 of the Standard. The requirements for grounding and power supplies supersede those requirements in Sections 15 and 35. The corrosion protection requirements specifically cover appliances constructed of cast ferrous metal, sheet steel, or ferrous tubing. These requirements apply only to those fans intended for use in indoor and outdoor wet locations subject to rain or the spray of non-corrosive and non-flammable liquids. These appliances may be exposed to the weather and may be unprotected. Also, see 5.1.

Exception: The enclosure of an evaporative cooler for use in windows is not required to comply with the requirements of 167.3, Exposure to sunlight (ultraviolet radiation).

166 Construction

166.1 General

166.1.1 The requirements found in 166.2.1 – 166.2.5 do not apply to a part such as a decorative grille that is not required to form a part of the enclosure.

166.1.2 Portable appliances intended for outdoor use shall include:

a) A ground-fault circuit-interrupter (GFCI) that complies with the Standard for Ground-Fault Circuit-Interrupters, UL 943, or portable appliance that complies with Section 48 of this standard;

b) A supply cord provided with the –R suffix when required by Table 15.1;

c) A cordset assembly, as specified in Table 15.1, with overcurrent protection that complies with Sections 16.3 – 16.6, or controller compliant with overcurrent protection per UL 60730; and

d) A marking in accordance with 168.4 as a tag either attached to the supply cord located within 6 in (152.4 mm) of the attachment plug or as an integral part of the attachment plug. For cord tag, it shall comply with the applicable requirements in the Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, for the intended cord surface, suitable temperature rating and limited slippage rating. Besides, the environmental condition of this cord tag shall be Outdoor Use.

166.2 Protection against corrosion

166.2.1 The inside and outside surfaces of cast ferrous metal, sheet steel, or ferrous tubing shall be protected against corrosion by one of the coatings described in Table 166.1.

Exception No. 1: Other finishes are not prohibited from being used, including paints, special metallic finishes, and combinations of the two, when it is determined that they provide equivalent protection by comparative tests with galvanized-sheet steel conforming with Type G90 of Table 166.1. Outdoor paint shall comply with the requirements in the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

Exception No. 2: A metal part, such as a decorative part, that is not required for conformance with this Standard is not required to be protected against corrosion.

Exception No. 3: Stainless steel is not required to be additionally protected against corrosion.

Exception No. 4: Edges, fasteners, and welds complying with 166.2.2 – 166.2.5 are not required to be additionally protected against corrosion.

Exception No. 5: When the inside surfaces of the appliance are protected from the elements such that no water enters the appliance during the water spray test, the inside surfaces are to be provided with protection against corrosion equivalent to that specified in 95.1 – 95.5.

Table 166.1
Sheet steel coatings

Type of coating	Minimum coating thickness [a], mm (inches) or weight (mass)	Additional topcoat(s)
(A) Hot-dipped mill galvanized steel designated		–
G90 or Z275	See note [b, c]	None
G60 or Z180	See note [b, c]	1 coat of outdoor paint[d]
A60 or ZF180	See note [b, c]	1 coat of outdoor paint[d]
(B) Zinc coating other than Type (A)	0.0155 (0.00061)[e]	None
	0.0104 (0.00041)[e]	1 coat of outdoor paint[d]
(C) Cadmium coating	0.0254 (0.0010)	None
	0.01905 (0.00075)	1 coat of outdoor paint[d]
	0.0127 (0.0005)	2 coats of outdoor paint[d]
(D) Vitreous enamel[f]	Not specified	None

[a] As determined by ASTM Method B555, Standard Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test, or ASTM B499, Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals, or ASTM B568, Standard Test Method for Measurement of Coating Thickness by X-Ray Spectrometry. Additional topcoats must be removed prior to measuring the metallic coating thickness.

[b] Conforming with the coating designation G90, G60, or A60 in accordance with ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, with no less than 40 percent of the zinc on any side based on the minimum single spot test requirement in this ASTM standard. Minimum coating weight (oz/ft^2) requirements for G90, G60, and A60 coating designations are specified in ASTM A653/A653M. The referee method for coating weight determination is ASTM A90/A90M, Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings. Additional topcoats must be removed prior to measuring the metallic coating weight.

[c] Conforming with the Z275, Z180 and ZF180 designation coating weight (mass) requirements (g/m^2) specified in ASTM A653/A653M, or ISO 3575, Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of commercial and drawing qualities. The referee methods for coating weight determination are ASTM A90/A90M or ISO 1460, Metallic Coatings – Hot Dip Galvanized Coatings on Ferrous Materials – Gravimetric Determination Of The Mass Per Unit Area. Additional topcoats must be removed prior to measuring the metallic coating weight.

[d] Identified as outdoor paint by paint manufacturer.

[e] Average thickness with a spot minus tolerance of 0.00178 mm (0.00007 inch).

[f] Acceptable on sheet steel at least 0.66 mm (0.026 inch) thick.

166.2.2 Hinges, bolts, and fasteners made of ferrous materials shall be protected against corrosion as described in 95.1 for damp locations.

Exception: Hinge pins are not required to be provided with the protection against corrosion required in 95.1.

166.2.3 The acceptability of a coating on hinges, bolts, and fasteners is to be determined by visual inspection.

166.2.4 Punched holes and cut edges in ferrous material are not required to be protected against corrosion.

166.2.5 Welds in iron or steel (other than stainless steel) shall be painted with one coat of any outdoor paint.

Exception: One coat of any indoor paint is acceptable over a spot weld on galvanized steel.

166.3 Field-wiring connections

166.3.1 An opening in an appliance for a power-supply or external control-circuit connection shall be threaded unless:

a) It is located entirely below the lowest uninsulated live part within the enclosure; or

b) Its location prevents drainage into the enclosure.

The metal at a threaded opening for a wiring system shall be a minimum 6.35 mm (1/4 inch) thick, and an end-stop shall be provided, unless the thread is tapered. See 166.6.2.

166.4 Internal wiring

166.4.1 Internal wiring of an appliance shall be of such type and assembled to reduce the risk of electric shock resulting from exposure to water or humidity.

166.4.2 There shall be no water on uninsulated live parts or on film-coated wire, other than motor windings, of an appliance as a result of the Water Spray Tests specified in 48.1.2.

166.4.3 Internal wiring of an appliance shall be located so that it is not immersed in water as a result of the appliance's exposure to the weather. Compliance with this requirement is determined by visual examination and by the Water Spray Test specified in Section 48.

166.4.4 The use of moisture-resistant wiring material such as Type RW, RHW, TW, XHHW, MTW, THW – MTW, or THWN, enclosed in rigid or flexible steel conduit, electrical metallic tubing, or moisture-resistant non-metallic sheathed cable, is considered acceptable for the wiring between electrical component enclosures. Wiring materials that are not inherently moisture resistant may be installed in either:

a) Rigid conduit or electrical metallic tubing with rain-tight fittings; or

b) Liquid-tight flexible metal or non-metallic conduit with acceptable fittings.

Bushings shall be nonabsorptive.

166.5 Insulating material

166.5.1 Electrical insulation used in the construction of an electrical component shall be nonabsorptive. Vulcanized fiber in a component is acceptable only when the component is not wetted during the water spray tests.

166.6 Enclosures

166.6.1 A panel or cover in the outer enclosure of an appliance shall require the use of a tool or tools for removal.

Exception: When removal or opening of the panel or cover does not result in a risk of electric shock when the appliance is subjected to the Water Spray Test specified in Section 48, it is not required to comply with this requirement.

166.6.2 The enclosure of an electrical component of a roof-mounted appliance shall have provision for drainage when a knockout or unthreaded opening is provided in the enclosure. See 166.6.1.

166.6.3 A non-metallic enclosure is to be judged on the basis of the effect of exposure to ultraviolet light and water as specified in 167.3.1.

166.6.4 An enclosure or enclosures shall be so constructed as to reduce the risk of electric shock due to weather exposure and to prevent the wetting of live parts, electrical components, or wiring not identified for use in contact with water. Parts identified for use in contact with water include flexible cords whose marking ends with a "W," liquid tight flexible metal or non-metallic conduit, outlet boxes marked for use in wet locations, rigid conduit, and the like.

Exception: The outer surface of the glass envelope of a lamp that is wetted meets the intent of this requirement.

166.6.5 An appliance shall be constructed so it prevents the entrance of any water into the enclosure.

Exception: When a drain hole is provided to drain water from the appliance, and water enters the appliance, there shall be no wetting of live parts as described in 166.6.4.

166.6.6 To determine compliance with 166.6.4 and 166.6.5, a complete assembly is to be installed as described in 166.6.7 and subjected to the Water Spray Test, Section 48.

166.6.7 During the Water Spray Test specified in Section 48, unspecified lengths of conduit are to be attached to the field wiring box with normal torque and without pipe-thread compound. At each unthreaded opening, a lock nut and bushing are to be installed. The unattached end of each conduit is to be closed to prevent the entrance of water.

166.6.8 A cover for a roof-mounted appliance having an area not more than 0.37 m^2 (4 square feet) shall be of a material classified as HB, V-0, V-1, V-2, or 5V. When the cover is required for the appliance to comply with the requirements of the rain test [see 48.1.1 (b) and (c)], then additional tests, such as impact, environmental conditioning, and ultraviolet exposure tests, are to be conducted on the material.

166.7 Grounding and power supply connections

166.7.1 A cord-connected wet location appliance shall employ a 3-conductor grounding type W-rated power supply cord, as specified by Table 15.1, and shall be provided with installation instructions as specified in 169.1.

Exception: Appliances with no parts requiring electrical continuity in accordance with 35.1.2, and having no dead metal parts likely to become energized which are in contact with water, are not required to be provided with an equipment grounding conductor.

167 Performance

167.1 Sealing compound

167.1.1 A sealing compound depended upon for protection from rain is to be conditioned as specified in 167.1.2. The sealing compound shall not melt, become brittle, or otherwise deteriorate to a degree that affects its sealing properties as determined by comparing the aged sample to an unaged sample.

167.1.2 To determine whether the sealing compound complies with the requirements in 167.1.1, it is to be applied to the surface it is intended to seal. For a surface having a temperature rise not exceeding 35°C

(95°F), a representative sample of the surface with the sealing compound applied is to be conditioned for 7 days in an air oven at 87.0 ±1.0°C (189.0 ±1.8°F).

167.2 Gasket

167.2.1 A gasket employed to comply with the requirements for outdoor use shall comply with the requirements of the thermal conditioning test in 167.2.3.

167.2.2 When an adhesive is used to secure a gasket, six samples of the gasket assembly are to be subjected to the gasket conditioning test described in 167.2.3. Following conditioning, removal of the gasket is to be attempted by pulling on the edge of the gasket in a plane perpendicular to the surface on which the gasket is mounted. The force necessary to remove the gasket from its mounting surface shall be at least 60 percent of the value measured prior to conditioning. Three samples are to be checked within 1/2 hour following conditioning and the remaining three samples are to be checked 24 hours after the test.

167.2.3 After conditioning for 168 hours in a circulating air oven at a temperature 20°C (68°F) above the temperature measured on the gasket or bushing during the temperature test, a gasket employed to comply with the requirements for wet location appliances shall have a tensile strength of not less than 60 percent and an elongation of not less than 75 percent of the values determined before conditioning.

Exception No. 1: This test is not required to be conducted when a gasket or bushing is tested while installed in the appliance as described in 167.2.4.

Exception No. 2: Neoprene rubber is acceptable for 60°C (140°F) and silicone rubber is acceptable for 105°C (221°F) without being subjected to the test.

167.2.4 As an alternative to the test described in 167.2.3, a gasket or bushing employed to comply with the requirements for wet locations is to be tested as follows. With the gasket(s) or bushing(s) in place, the appliance is to be conditioned in a circulating air oven for 240 hours at 20°C (68°F) above the temperature measured during the Temperature Test described in Section 46. After the conditioning, any parts which depend on the gasket or bushing for sealing are to be removed. The results are acceptable when a visual inspection shows no damage to the gasket and the gasket has remained in place with respect to the part removed. The appliance parts, including the gasket that was conditioned, are then to be replaced and the appliance subjected to the appropriate water spray test. After the water spray, any part which depends on the gasket or bushing for sealing is to be removed. The results are acceptable when a visual inspection shows no damage to the gasket, and the gasket has remained in place with respect to the part removed.

167.3 Exposure to sunlight (ultraviolet radiation)

167.3.1 A non-metallic enclosure or watershield of a fan employing a fluorescent light or a non-metallic enclosure of a fan intended for outdoor use shall withstand 720 hours of twin enclosed carbon-arc or 1000 hours of xenon-arc conditioning in accordance with the Ultraviolet Light Exposure Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, without impairment of its impact resistance when tested as specified in 167.3.2.

167.3.2 Each of three non-metallic enclosure samples are to be exposed to ultraviolet radiation. After ultraviolet exposure as specified in 167.3.1, each sample is to be removed from the ultraviolet radiation and within 1 minute be subjected to an impact of 1.4 J (1 foot-pound) by means of a solid, smooth, steel sphere, 50.8 mm (2 inches) in diameter, applied to the external surfaces. The sphere is to be dropped from the height necessary to produce the specified impact upon the surface being tested. For a surface that is not horizontal, the sphere is to be suspended by a cord and swung vertically as a pendulum from the necessary distance.

168 Marking

168.1 A cord-connected portable or non-portable appliance intended for outdoor use shall be plainly marked "CAUTION" and the following or the equivalent: "To Reduce The Risk Of Electric Shock, Connect Only To An Outlet Provided With A Ground Fault Circuit Interrupting Device."

Exception: This marking is not required when a GFCI device is provided as a part of the appliance.

168.2 An appliance that complies with the requirements in Sections 165 – 168 and that is intended for use in wet locations shall be marked "OUTDOOR USE" or "ROOFTOP USE".

168.3 A cord-connected outdoor use appliance shall be marked with the following or equivalent wording: "Do Not Use An Extension Cord With This Fan."

168.4 A portable appliance intended for outdoor use shall be marked "Suitable for Outdoor Use" in accordance with 166.1.2(d).

169 Instructions

169.1 A cord-connected portable or non-portable appliance intended for outdoor use shall be provided with installation instructions that consist of the following or equivalent wording: "Use Only on GFCI Protected Receptacles."

Exception: This marking is not required when a GFCI device is provided as a part of the appliance.

169.2 When user servicing or cleaning operations are anticipated, the instructions shall indicate that the source of electrical supply is to be disconnected prior to the beginning of any such servicing or cleaning operation.

DAMP LOCATION COMPONENT FANS

170 General

170.1 Damp location component fans are component fans intended to be installed in end products which are suitable for installation in interior locations protected from weather and subject to moderate degrees of moisture (such as some basements, barns, cold storage warehouses, and similar locations), and also partially protected locations (such as under canopies, marquees, roofed open porches, and similar locations).

170.2 In addition to the applicable requirements in Part 1 of this Standard, the component fan shall also comply with the requirements in Sections 48 (Water Spray Test), 95 (Construction – Protection Against Corrosion), and 96 (Construction – Electrical).

Exception: A low voltage component fan shall comply with the low voltage component fan requirements described in Sections 189 – 193 in addition to Sections 48, 95, and 96.1.

171 Construction

171.1 If the fan employs encapsulation materials (such as epoxy, polyurethane, silicone rubber) which are required for compliance to the Water Spray Test, the encapsulation material shall comply with the applicable requirements of the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C.

171.2 For an encapsulation material as described in 171.1, the Water Spray Test should be conducted before and after the Thermal Cycling Test of 176.1.

Exception: The Thermal Cycling Test of 176.1 can be waived if an epoxy material is employed and if the epoxy material does not exceed 90°C (with T_{mra} factored in) during the Temperature Test.

171.3 Use of conformal coatings on the printed wiring board for protection against environmental conditions or used in lieu of electrical spacings shall be evaluated to the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C.

171.4 Use of sealants and gaskets required for compliance to the Water Spray Test, Section 48, shall comply with 167.1 and 167.2.

172 Performance

172.1 Damp location component fans shall be subjected to the Thermal cycling test, 176.1.

173 Markings

173.1 A component fan in compliance with all applicable requirements including enclosure requirements and environmental conditioning shall be marked "Suitable for Use in Damp Locations".

WET LOCATION AND OUTDOOR-USE COMPONENT FANS

174 General

174.1 Wet location and outdoor-use component fans are component fans intended to be installed in end products which are suitable for locations which are unprotected and exposed to weather.

174.2 In addition to the applicable requirements in Part 1 of this Standard, a component fan shall also comply with the requirements in Sections 166, Construction, and 167, Performance. A low voltage component fan shall comply with the requirements specified in Sections 189 – 193, 166, and 167.

175 Construction

175.1 If the fan employs encapsulation materials (such as epoxy, polyurethane, silicone rubber) which are required for compliance to the Water Spray Test, Section 48, the encapsulation material shall comply with the applicable requirements of the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C, and comply with 167.3, Exposure to sunlight (ultraviolet radiation).

175.2 For an encapsulation material as described in 175.1, the Water Spray Test should be conducted before and after the Thermal Cycling Test of 176.1.

Exception: The Thermal Cycling Test of 176.1 can be waived if an epoxy material is employed and if the epoxy material does not exceed 90°C (with T_{mra} factored in) during the Temperatue Test.

175.3 Use of sealants and gaskets required for compliance to the Water Spray Test, Section 48, shall comply with 167.1 and 167.2.

175.4 Use of conformal coatings on the printed wiring board for protection against environmental conditions or used in lieu of electrical spacings shall be evaluated to the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C.

176 Performance

176.1 Thermal cycling test

176.1.1 For components or subassemblies which are adequately enclosed by enveloping or hermetic sealing to prevent ingress of dirt and moisture, examples of such construction include parts in boxes that are hermetically sealed by adhesive or otherwise, and parts enveloped in a dip coat, compliance is checked by inspection from the outside, measurement and test. A component or subassembly is considered to be adequately enclosed if a sample passes the following sequence of tests.

The sample is subjected 10 times to the following sequence of temperature cycles:

68 h at T_1°C ± 2°C
1 h at 25°C ± 2°C
2 h at 0°C ± 2°C
not less than 1 h at 25°C ± 2°C

Where:

$T_1 = T_2 + T_{mra} - T_{amb} + 10°C$, *or 85°C, whichever is higher;*

T_2 = *the temperature of the parts measured during the Temperature Test;*

T_{amb} = *the room ambient temperature during the Temperature Test; and*

T_{mra} = *the maximum room ambient temperature permitted by the manufacturer's specification or 25°C, whichever is greater.*

176.1.2 The period of time taken for the transition from one temperature to another is not specified, but the transition is permitted to be gradual.

176.1.3 The sample is allowed to cool to room temperature and is subjected to the Humidity Conditioning Test of Section 53, followed by the Dielectric Voltage Withstand Test of Section 47.

176.1.4 For transformers, magnetic couplers and similar devices, where insulation is relied upon for safety, a voltage of 500 V r.m.s at 50 Hz to 60 Hz is applied between windings during the thermal cycling conditioning. No evidence of insulation breakdown shall occur during this test.

177 Markings

177.1 Component fans in compliance with all applicable requirements including enclosure requirements and environmental conditioning shall be marked "Suitable for Use in Wet Locations" or "Suitable for Outdoor-Use".

FANS FOR USE IN UNATTENDED AREAS

178 General

178.1 In addition to any other motor requirements specified in this standard, the requirements specified in Sections 178 and 179A apply to any motor used in fan products which are built into or within the building structure and which operate unattended or in situations in which the operator may not detect or be notified of a locked rotor condition.

Note 1: Examples include wall-insert fans, through-wall fans, ceiling-insert fans, attic exhaust fans, whole house fans, and duct fans.

Note 2: See Appendix B "Section 178 and 179A Flow Chart requirements reference guides".

Exception No. 1: These requirements do not apply to range hoods with integral blowers, downdraft fans with integral blowers, ceiling suspended fans, low voltage component fans, polyphase commercial and industrial fans that are marked for commercial or industrial use, and recreational vehicle fans rated 24 V or less.

Exception No. 2: These requirements do not apply to fans or motors employing an Electronically Protected Motor that complies with UL1004-7 that uses methods in addition to or other than a motor winding temperature sensing device(s).

178.2 A secondary protection device provided for supplemental-fuse overcurrent protection shall comply with one of the following:

a) Supplementary Protectors for Use in Electrical Equipment, UL 1077, or

b) Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14

178.3 A secondary protection device shall be suitable for its use in the fan or motor, including:

a) Have a voltage rating at least that of the voltage it is subject to in the application;

b) Have a temperature rating suitable for the temperature measured on the secondary protection during normal operation;

c) Not be an automatic reset type;

d) A secondary protector with contacts that are intended to open during an overcurrent situation shall comply with UL 1077 tested at 6 times the full load current rating of the motor, or shall be additionally subject to the Switch Overload Test, Section 59.1 of UL 507.

e) Supplemental-fuse overcurrent protection shall be capable of clearing a fault current (interrupt rating), as tested per the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14 or the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077, of not less than 1,000 Amps for a nominal 115 V circuit, and 1,000 Amps for a nominal 240V circuit. When the fuse is located in the fan or motor downstream of another current limiting device, the fault current clearing capability of the supplemental-fuse overcurrent protection shall be suitable for the maximum fault current capable of being imposed on the device.

178.4 A fan or motor that uses a secondary protection device that is relied upon during Fan Motor Failure Analysis, 179A.2, shall be evaluated as a specific fan/motor/protector combination. When the fan or motor, the secondary protection device, or the fan/motor/secondary protection device combination is changed, the combination shall be reevaluated.

178.5 For a polarized motor, the secondary protection device(s) shall be connected in the ungrounded (line) conductor of the supply circuit only. For an unpolarized motor, the secondary protection device(s) shall be connected on both the ungrounded and grounded (neutral) conductors such that when it operates, it opens either or both ungrounded and grounded conductors.

179 Performance

179.1 Test preparation – fan motor failure mode analysis

179.1.1 *Deleted*

179.1.2 *Deleted*

179.1.3 *Deleted*

179.1.4 *Deleted*

179.1.5 *Deleted*

179.2 Test procedure – fan motor failure mode analysis

179.2.1 *Deleted*

179.2.2 *Deleted*

179.2.3 *Deleted*

179A Performance

179A.1 Fan motor heat aging

179A.1.1 The test procedure specified in this Section is to be conducted on either fifteen samples of a complete fan or fifteen samples of the motor.

Exception: The requirements in 179A.1 do not apply to fans or motors that comply with Exception of 179A.2.1, the Fan motor failure analysis alternate path.

179A.1.2 Five samples of a complete fan or five samples of the motor, shall be modified to bypass the primary motor overload protection device, or to assemble the motor with a non-functioning device so as to be as close to true production process as possible, prior to conducting the tests in 179A.1.1 – 179A.1.5. These samples shall not be subject to the Locked-Rotor test per 179A.1.6. These five samples are to be tested per 179A.2 after the heat aging period. See Table 179A.1.

Note: It is suggested that these modifications should be performed by the motor manufacturer at the time of assembly to reduce the possibility of invasive after-market alterations compromising the integrity of the tests. As an example the primary protection device may be bypassed by shorting or replacing with a working dummy protector to prevent it from operating during the testing.

Table 179A.1
Fan/motor aging and failure test matrix

Motor/fan samples	179A.2.1 Exception – Fan motor failure analysis alternate path	Motor/fan construction	Heat aging test	Locked rotor test after heat aging	Fan motor failure test
10 production samples[4]	No	Primary protection and secondary protection devices All protectors intact and unaltered[1]	Yes	Yes	No
	Yes[4]	N/A	N/A	N/A	N/A
5 samples[3]	No	All primary protection methods	Yes	No	Yes[3]

Table 179A.1 Continued on Next Page