UL 998

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Humidifiers

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Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
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UL Standard for Safety for Humidifiers, UL 998

Fourth Edition, Dated November 7, 2001

Revisions: This Standard contains revisions through and including May 12, 2006

Summary of Topics

1. Clause 20.19 and Table 10 are revised to delete the adjective ″natural″ from the term ″natural gray″.

2. Clause 40.5A is added to allow symbols ″I″ and ″O″ to represent ″ON″ and ″OFF″ respectively.

3. Clauses 42.11 and 41.12 are revised to clarify spacing requirements.

4. Table 8 is revised to correct typographic errors.

5. Annex A is revised to update references.

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The new and/or revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated January 27, 2004. The bulletin(s) is now obsolete and may be discarded.

The revisions dated May 12, 2006 include a reprinted title page (page1) for this Standard.

Please note that the UL and CSA versions of this Standard are identical. However, because of differences in publishing systems, UL has issued some pages (C3 and C4) with a May 12, 2006 date. In the CSA version of the Standard these pages are dated November 7, 2001.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-3	May 12, 2006
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5	June 23, 2003
6-8	May 12, 2006
9-27	November 7, 2001
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Commitment for Amendments

This Standard is issued jointly by the Canadian Standards Association (CSA) and Underwriters Laboratories Incorporated (UL). Amendments to this Standard will be made only after processing according to the Standards writing procedures of CSA and UL.

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

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Preface

This is the common UL and CSA Standard for Humidifiers. It is the third edition of CSA Standard C22.2 No. 104, superseding editions published in 1993 and 1983, and the fourth edition of UL 998.

This common Standard was prepared by the Canadian Standards Association (CSA) and Underwriters Laboratories Inc. (UL). The efforts and support of the Air Conditioning and Refrigeration Institute (ARI) and the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) are gratefully acknowledged.

This Standard was reviewed by the CSA Subcommittee on C22.2 No. 104 under the jurisdiction of the Technical Committee on Consumer and Commercial Products and the Strategic Resource Group, and has been formally approved by the Technical Committee.

This standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

The most recent designation of ANSI/UL 998 as an American National Standard occurred on April 28, 2006.

This ANSI/UL Standard for Safety, which consists of the fourth edition (with revisions through May 12, 2006), is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

A UL standard is current only if it incorporated the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

Note: Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

Level of harmonization

This standard uses an IEC format, but is not based on, nor shall it be considered equivalent to, an IEC standard. This standard is published as an identical standard for UL and CSA.

An identical standard is a standard that is the same in technical content except for conflicts in Codes and Governmental Regulations. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the SDO of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the SDO. If more than one interpretation of the literal text has been identified, a revision is proposed as soon as possible to each of the SDO's to more accurately reflect the intent.

UL Effective Date

A UL effective date is one established by Underwriters Laboratories Inc. and is not part of the ANSI approved standard.

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CSA Effective Date

The effective date for CSA International will be announced through *CSA Informs* or *CSA Certification Notice*.

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HUMIDIFIERS

INTRODUCTION

1 Scope

1.1 These requirements cover humidifiers rated 600 V or less, and intended to be used in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, and the Rules of the Canadian Electrical Code (CEC), Part 1, C22.1.

1.2 These requirements cover humidifiers intended for residential and commercial use. This includes humidifiers of the centrifugal atomizing type, evaporative-media type, water-injection type, steam type, and the like. The humidifiers may be for installation in a room, mounted on a wall or a ceiling, or for duct or plenum mounting.

1.3 These requirements apply to equipment that includes an electric heating element to heat air or water, or both.

1.4 These requirements do not apply to evaporative coolers that are also intended to be used for cooling.

1.5 These requirements do not apply to portable, electrode-type products, such as vaporizers, which are covered by the Standard for Electric Heating Appliances, UL 499, and the CSA Standard for Household Cooking and Liquid-Heating Appliances, CAN/CSA-C22.2 No. 64.

2 Definitions

2.1 The following definitions apply in this Standard:

Circuit, extra-low-voltage – A circuit that has an ac potential of not more than 30 V (42.4 peak), and power of 100 VA or less; or 30 V dc supplied by a primary battery; or supplied by a Class 2 transformer; or supplied by a combination of a transformer and fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer. A circuit that is derived from a circuit which exceeds 30 V by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not considered to be an extra-low-voltage circuit.

Circuit, hazardous voltage – A circuit having characteristics in excess of those of an extra-low-voltage circuit.

Combination temperature-regulating and temperature-limiting thermostat – A thermostat whose function is to regulate the temperature under normal conditions of use, and that also serves to prevent a hazard that might result from conditions of abnormal operation of the heater.

Enclosure – The enclosure that houses the electrical components, live parts and/or moving parts. It may be an integral part of the component, a separate item, part of the ultimate enclosure, or the ultimate enclosure (e.g., the outer cabinet).

Heater element – A complete or partial assembly of a heating element, an electrical insulation (e.g., refractory, mica), a metal sheath, a glass or quartz envelope or panel, thermal insulation, and a frame or adaptor for holding the assembly together and fastening it in the heater; and leads or terminal connections, or both, which may or may not include bolts and nuts.

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Heating element – The actual electrical conducting medium that is intended to be heated by an electric current.

Humidifier – Equipment that is designed to increase the relative humidity of air.

Junction block – A wiring device that encloses splices between wires and that may provide a receptacle for connecting a component of the equipment.

Safety-circuit – A circuit that includes contacts of any controls integral with, or external to, the equipment that are intended to prevent unsafe operation of the equipment due to circuit wiring becoming grounded, open circuited, or short circuited, such as:

a) A device to prevent overheating of a motor due to overload (including locked rotor);

b) A temperature limit switch, the failure of which to operate might result in an unsafe operation; or

c) A pressure-limiting device in a system, the failure of which to operate might result in an unsafe condition.

Temperature-limiting thermostat – A thermostat that functions only under conditions that produce abnormal temperatures. The failure of such a thermostat might result in a hazard.

Temperature-regulating thermostat – A thermostat that functions only to regulate the temperature under normal conditions of use. The failure of such a thermostat would not result in a hazard.

User servicing – Any form of servicing that may be performed by personnel other than those who are trained to maintain the product. Some examples include routine cleaning, filter replacement, and replacement of an accessible fuse or lamp.

3 General

3.1 Components

3.1.1 Except as indicated in Clause 3.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Annex A for a list of Standards covering components used in the products covered by this Standard. A component shall comply with the CSA International and the Underwriters Laboratories, Inc. standards.

3.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

3.1.4 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.

3.2 Reference publications

3.2.1 Where reference is made to other publications, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this Standard was approved.

CSA Standards

B51-97,
Boiler, Pressure, Vessel, and Pressure Piping Code

C22.1-1998,
Canadian Electrical Code, Part 1

C22.2 No. 0.3-01,
Test Methods For Electrical Wires and Cables

C22.2 No. 0.15-95 (R1999),
Adhesive Labels

CAN/CSA-C22.2 No. 0.17-00,
Evaluation of Properties of Polymeric Materials

CAN/CSA-C22.2 No. 64-M91 (R1999),
Household Cooking and Liquid-Heating Appliances

C22.2 No. 72-M1984 (R1999),
Heater Elements

C22.2 No. 77-95 (R1999),
Motors with Inherent Overheating Protection

C22.2 No. 100-95 (R2000),
Motors and Generators

UL Standards

UL 73,
Motor-Operated Appliances

UL 94,
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of

UL 486A,
Wire Connectors and Soldering Lugs for Use with Copper Conductors

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UL 499,
Electric Heating Appliances

UL 723,
Tests for Surface Burning Characteristics of Building Materials

UL 746C,
Polymeric Materials – Use in Electrical Equipment Evaluations

UL 900,
Air Filter Units

UL 969,
Marking and Labeling Systems

UL 1004,
Motors, Electric

UL 1030,
Sheathed Heating Elements

UL 1581,
Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 2111,
Overheating Protection for Motors

Other Standards

ANSI/NFPA No. 70,
National Electrical Code

ASME,
Boiler and Pressure Vessel Code

ASTM D395,
Standard Test Methods for Rubber Property – Compression Set

ASTM E162,
Standard Test Method for Surface Flammability of Materials, Using a Radiant Heat Energy Source

CAN/ULC-S102-M88,
Standard Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies

Abbreviations

ANSI – American National Standards Institute

ASHRAE – American Society of Heating, Refrigerating, Air-Conditioning Engineers

ASME – American Society of Mechanical Engineers

ASTM – American Society for Testing and Materials

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BOCA – Building Officials and Code Administrators International

CGA – Canadian Gas Association

NFPA – National Fire Protection Association

ULC – Underwriters Laboratories of Canada

3.3 Units of measurement

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

3.4 Terminology

3.4.1 In the following text, a requirement that applies only to a particular type of humidifier is so identified by a specific reference in that requirement to the type or types of humidifiers involved. Absence of such specific reference or use of the term ″product″ indicates that the requirement applies to all types of humidifiers unless the context indicates otherwise.

CONSTRUCTION

4 General

4.1 A product shall be completely assembled when it is shipped from the factory.

Exception: A product may be shipped partially disassembled, to facilitate packaging or installation, if proper assembly can be accomplished without a risk of fire, electric shock, or injury to persons, and each part is marked as required by Clause 76.1.3.

4.2 A product intended for mounting to the ceiling, floor, or wall shall have provisions for such mounting. All required fittings such as brackets, hangers, or the like, necessary for mounting shall be furnished with the product.

Exception: Parts commonly available for the mounting of the product need not be provided if mounting instructions that refer to such parts are furnished in accordance with Clause 76.1.8.

4.3 A humidifier that is intended for mounting on the hot air plenum or duct of a furnace, and that requires the installation of an air deflecting means in the path of the moving air, shall include the necessary deflecting means as a part or accessory of the humidifier, and shall be accompanied by explicit instructions for the installation of the means so as to avoid impairment of the function of the furnace.

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5 Enclosures

5.1 General

5.1.1 Products shall be constructed so that they have the strength and rigidity necessary to resist the abuse to which they may be subjected, without increasing the risk of fire, electric shock, or injury to persons, due to partial collapse with resultant reduction of spacings, loosening or displacement of parts, or other defects.

5.1.2 In determining compliance with Clause 5.1.1, all elements that contribute to the enclosing function, including enclosures of individual components and the exterior (decorative) cabinet, shall be considered.

5.1.3 Enclosures made in the form of grilles, etc, of wire or sheet metal, and intended to accommodate air flow required for the operation of the equipment, shall be considered to comply with Clause 5.1.1, if they provide resistance to deflection or impact that would be acceptable to the requirements specified in Clause 5.1.4 for enclosures of sheet metal.

5.1.4 Cast and sheet-metal sections of an enclosure shall not be thinner than specified in Table 1.

Exception: Thinner metal may be used provided the surface under consideration is curved, ribbed, or otherwise reinforced to provide mechanical strength equivalent to that required.

5.1.5 A metal plate or metal plug used to cover an unused conduit opening or other hole that is required to be covered in the enclosure shall have a thickness not less than:

a) 0.35 mm (0.014 in) if steel, or 0.48 mm (0.019 in) if nonferrous metal, for a hole having a 6.4 mm (1/4 in) maximum dimension; and

b) 0.68 mm (0.027 in) if steel, or 0.81 mm (0.032 in) if nonferrous metal, for a hole having a 34.9 mm (1-3/8 in) maximum dimension. A closure for a larger hole shall have a thickness no less than that required for the enclosure of the product. Such plates or plugs shall be securely mounted.

5.2 Nonmetallic materials

5.2.1 Enclosures or parts of equipment manufactured, of nonmetallic materials, shall not cause a risk of fire, electric shock, or injury to persons, because of susceptibility to ignition or melting by electrical disturbances within, or because of deterioration from aging effects, or exposure to the operating environment.

5.2.2 Enclosures shall be considered to comply with Clause 5.2.1 if:

a) They comply with the flammability test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C, and the CSA Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA-C22.2 No. 0.17;

b) They have temperature ratings not less than the maximum temperatures to which they may be exposed during normal operation; and

c) The equipment is in compliance with Clauses 5.2.3, 5.2.4, and 5.2.5.

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5.2.3 In addition to the requirements of Clause 5.2.1, an enclosure of polymeric material having in any unbroken section an exposed surface greater than 0.93 m^2 (10 ft^2), or a single dimension greater than 1.83 m (6 ft), shall have maximum flame spread rating of:

a) 200 for a portable product, and

b) 50 for a product intended to be permanently connected to the electrical supply.

5.2.4 The flame spread rating mentioned in Clause 5.2.3 shall be determined in accordance with the requirements in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or the radiant panel test requirement in accordance with the Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162, or the Standard Methods of Tests for Surface Burning Characteristics of Building Materials and Assemblies, CAN/ULC-S102.

5.2.5 Where bare live parts of electrical components, such as switch terminals, are individually enclosed with metal, or polymeric material that complies with the requirements of the vertical burning test for classifying materials 5 VA in accordance with the Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and Flammability Rating of 5V (500 W), in the CSA Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA-C22.2 No. 0.17, the surrounding equipment enclosure may be of material that is not more flammable than material classed as HB as specified in CAN/CSA-C22.2 No. 0.17, and HB as specified in UL 94, provided:

a) The equipment does not employ open-coil heaters;

b) Internal wiring within the surrounding equipment enclosure complies with flame test classification VW-1 as referenced in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581, and FT1 of the CSA Standard for Test Methods for Electrical Wires and Cables, C22.2 No. 0.3;

c) Splices within the surrounding equipment enclosure are made with insulated wire connectors that are resistant to loosening due to vibration; and

d) The surrounding equipment enclosure, where relied upon to prevent a risk of electric shock, complies with the impact test requirements of Clause 59.

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5.3 Enclosure integrity

5.3.1 The enclosure of a product shall reduce the likelihood that molten metal, burning insulation, flaming particles, or the like will fall on combustible materials, including the surface upon which the product is supported.

5.3.2 The requirement in Clause 5.3.1 necessitates the use of a barrier under wiring, unless it is neoprene- or thermoplastic-insulated, and under a motor unless:

a) The structural parts of the motor or the product provide the equivalent of such a barrier;

b) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the product when the motor is energized under each of the following fault conditions:

1) Open main winding;

2) Open starting winding;

3) Starting switch short-circuited; and

4) Capacitor of permanent-split capacitor motor short-circuited – the short circuit is to be applied before the motor is energized, and the rotor is to be locked.

c) The motor is provided with a thermal motor protector, that is, a protective device that is sensitive to temperature and current that keeps 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

d) The motor complies with the requirements for impedance-protected motors in the Standard for Overheating Protection for Motors, UL 2111, and the CSA Standard for Motors with Inherent Overheating Protection, C22.2 No. 77.

5.3.3 The requirements in Clause 5.3.1 will also necessitate that a switch, a relay, a solenoid, or the like, be individually and completely enclosed.

Exception No. 1: The terminals of a switch, a relay, a solenoid, or the like need not be completely enclosed.

Exception No. 2: A component need not be completely enclosed if:

a) Malfunction of the component would not result in a risk of fire or

b) There are no openings in the bottom of the product enclosure.

5.3.4 The barrier mentioned in Clause 5.3.2 shall be horizontal, shall be located as illustrated in Figure 1, and shall have an area not less than that described in the illustration. Openings for drainage, ventilation, and the like, that would not permit molten metal, burning insulation, or the like, to fall on combustible material, may be employed in a barrier.

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5.3.5 If an opening for ventilation is provided in the enclosure of a product or an externally mounted component, and if the product is intended to be recessed into a wall or false ceiling, such an opening shall not allow venting into concealed space.

6 Doors and Covers

6.1 Doors and covers that give access to uninsulated live hazardous voltage parts shall be secured firmly in place, and shall require the use of a tool or key to open them or shall be provided with an interlocking mechanism; however, components having covers that comply with their respective standards do not require additional enclosures.

6.2 An interlocking mechanism complies with the requirements of Clause 6.1 if it:

a) Secures the cover in the closed position when engaged and

b) Must be engaged before parts in a hazardous voltage circuit can be energized.

6.3 Accessibility shall be afforded to all parts that require normal servicing or adjustment (for example, controls, filters, oiling of bearings, adjustment of belts) when the equipment is installed as intended. Covers or access panels giving access to such parts that are required to be removed for routine maintenance shall not expose uninsulated live parts.

6.4 The assembly shall be arranged so that any overcurrent protective device that can be replaced or reset as required is accessible without removal of parts other than the service covers or panels.

6.5 The door or cover of an enclosure shall be hinged, sliding type, pivoted, or the equivalent, and not intended for removal, if it gives access to any overcurrent protective device. If more than one door or cover has to be opened to provide access to the overcurrent protective device, only one of these needs to comply with this requirement.

Exception: A cover, panel, door, or other part of an enclosure that, because of its function or size, obviously must be in place to complete the overall enclosure, need not be hinged, sliding type, or pivoted.

6.6 A cover as specified in Clause 6.5 is not required if fuses only of the following types are enclosed:

a) Fuses connected in extra-low-voltage circuits;

b) Extractor type fuses that have their own enclosures;

c) Control circuit fuses provided that the control circuit loads (other than fixed loads, such as pilot lamps) are housed in the same enclosure as the fuses; or

d) Supplementary type fuses rated 2 A or less used in small, auxiliary resistance heater circuits having a maximum rating of 100 W.

6.7 The reset button or lever of manual resettable devices (for example, the operating handle of a circuit breaker, the reset button of a motor protector, the reset button of a pressure switch, the adjusting screw or knob of an adjustable temperature or pressure control) may be accessible without the use of a tool, provided that the resetting of the device does not result in exposure to uninsulated live hazardous voltage parts or moving parts.

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7 Accessibility of Uninsulated Hazardous Voltage Live Parts and Film-Coated Wire

7.1 To reduce the risk of unintentional human contact with an uninsulated live part or film-coated wire, louvers or other openings in the enclosure of a product, and openings in a motor, shall be so designed, located, or baffled as to comply with the requirements specified in Table 2.

7.2 With respect to the requirement in Clause 7.1, insulated brush caps do not require additional enclosure.

7.3 In determining compliance with Clauses 7.1 and 7.2, any doors, covers, or components that are intended to be removed for routine maintenance purposes, or that may be removed, without using a tool, by the user to attach an accessory, to make an operating adjustment, or for other reasons, shall be removed.

7.4 In cord-connected humidifiers where the enclosure of a fan is completed by a drum supporting the evaporating medium, a marking in accordance with Clause 75.19 shall be acceptable.

7.5 The probes illustrated in Figures 2 – 5 are to be applied to any depth that the opening enables and with a force not greater than 4.4 N (1 lbf), and are to be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the product or motor. The probe illustrated in Figure 2 is to be applied in any possible configuration, and, when required, the configuration is to be changed after insertion through the opening.

7.6 With reference to the requirements in Table 2, an indirectly accessible motor is a motor:

a) That is accessible only by removing a part of the outer enclosure of a product, such as a guard or panel, that can be removed without using a tool; or

b) That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

7.7 With reference to the requirements in Tables 2 and 3, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening perpendicular to the plane of the opening with a force not greater than 22 N (5 lbf).

7.8 If Table 2 specifies a probe to be used to judge the accessibility of an uninsulated live part or film-coated wire, the probe shall not contact such a part or wire when inserted through an opening in the enclosure of a product or motor as described in Clause 7.5.

7.9 If Table 2 does not specify that a probe is to be used to judge the accessibility of an uninsulated live part or film-coated wire, such a part or wire shall not be:

a) Within ″X″ mm (inches) of the perimeter of an opening in the enclosure of a product or a motor; or

b) Within the volume generated by projecting the perimeter ″X″ mm (inches) normal to its plane. ″X″ equals five times the minor dimension of the opening, but not less than the values specified in Table 2. Please see Clause 7.7 and Figure 6.

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7.10 Each lampholder shall be wired so that the screw shell will be connected to the conductor intended to be connected to the grounded conductor of the power-supply circuit.

8 Protection Against Risk of Injury to Persons – Mechanical Protection

8.1 All moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact.

8.2 Openings in external enclosures or guards provided for compliance with the requirements specified in Clause 8.1 shall be acceptable if they prevent the probe, illustrated in Figure 7, applied at any angle, from making contact with moving parts.

Exception: Openings of 25.4 mm (1 in) or larger shall be guarded such that the distance from an opening to the moving part is in accordance with Table 3.

8.3 An interlocking mechanism that operates to disconnect power to the drive motor when a cover or panel is removed or opened to provide access to moving parts is considered to provide the protection required by Clause 8.1.

8.4 An enclosure or guard over a rotating member, such as a fan blade, shall retain a part that, because of breakage or other reason, might become loose or separate from a rotating part, and shall retain foreign objects that might be struck and propelled by the rotating member.

8.5 A guard or portion of an enclosure acting as a guard for a part presenting a risk of injury to persons shall be:

a) Mounted to the assembly so that the part cannot be operated with a guard removed;

b) Secured to the assembly using fasteners requiring a tool for removal; or

c) Provided with interlocks to protect against access. Perforated sheet steel or expanded steel mesh used to cover openings shall give equivalent mechanical strength to that of a blank sheet of the thickness that will be required when determining compliance with Table 1.

8.6 A fan blade of conventional construction shall be acceptably guarded if:

a) The relationship between the weight (W) of the fan blades and hub in kilograms, the radius (r) in millimeters, and the speed (N) in revolutions per minute is such that K in the formula

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

is less than 29,032; and

b) The guarding is such that the probe illustrated in Figure 7 cannot touch the leading edge of the blade and hub when inserted with a force of 4.4 N (1 lbf) or less through any opening in the guard. For a reversible fan, both edges are leading edges.

9 Protection Against Risk of Injury to Persons – Materials

9.1 When breakage of materials used for the enclosure, frame, guard, or the like might result in a risk of injury, the materials shall have such properties that meet the demands of expected loading conditions. See Impact, Clause 59.

10 Protection Against Risk of Injury to Persons – Switches, Controls, and Interlocks

10.1 A device that automatically starts a product, such as a timer, an automatically reset overload-protective device, or the like, shall not be employed if such a device and its operations can cause or result in injury to persons.

10.2 The requirement in Clause 10.1 shall necessitate the use of an interlock if moving parts or the like would result in a risk of injury to persons upon the automatic starting or restarting of a motor. A product shall be constructed so as to reduce the likelihood of unintentional operation of any such part.

10.3 Each function of a multiple-function product shall be taken into consideration in determining compliance with Clause 10.2.

10.4 If unintentional operation of a switch can result in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation is unlikely. The actuator of such a switch may be guarded by recessing, use of ribs, barriers, or the like.

10.5 A risk of injury to persons shall not result when a product that is provided with a switch that can be locked in the ″on″ position is connected to the electrical source of supply when the product is in an at-rest position and the switch is in the ″on″ position.

10.6 The ″off″ position of a switch other than a momentary-contact type shall be such that the operator can determine by visual inspection that the product is off.

10.7 An interlock provided to reduce the risk of electric shock shall be constructed and installed so that it is reliable and complies with the requirements in Clause 10.8 or 10.9.

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10.8 An interlock shall be such that it cannot be defeated readily:

a) Without damaging the product;

b) Without making a connection or alteration to the wiring;

c) Without a tool; or

d) With a material that is commonly available, such as adhesive tape, string, and a conventional extension cord set.

10.9 A product having an interlock to reduce the risk of electric shock that does not comply with the requirements in Clause 10.8 shall be marked as specified in Clause 75.25, and during intended operation and user servicing of the product:

a) The interlock shall not be likely to be defeated by improper disassembly, for example, removal of the wrong screws during removal of the cover;

b) The cover in which the interlock is mounted shall not rotate by its own weight during any stage of its removal or replacement, if such rotation gives access to a live part, or damages the interlock or the cover;

c) The act of removal or replacement of the interlocked cover shall not subject the user to unintentional contact with live parts; and

d) Misapplication of the interlocked cover shall not result in a risk of electric shock unless such misapplication is obvious during and after replacement of the cover.

11 Protection Against Risk of Injury to Persons – Surface Temperatures

11.1 During the Normal-Temperature Test, Clause 57, the temperature of a surface that may be contacted by the user shall not exceed the applicable value specified in Table 4. If the test is conducted at a room temperature other than 25°C (77°F), the results are to be corrected to that temperature.

12 Stability

12.1 A portable product shall not overturn when positioned in its most unstable condition, with or without water, and tipped through an angle of 10 degrees from the horizontal.

12.2 The product shall be levelled on a horizontal surface. The side of the product that will result in the most severe test shall be raised until the product is tipped through an angle of 10 degrees. For the test, casters, wheels, and other supporting means shall be positioned so as to result in the least stability. If adjustable feet are provided, they shall be adjusted to the same height. The product shall be blocked to prevent sliding during the test.

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13 Strength of Handles

13.1 A handle used to support or carry a product shall withstand a force equal to four times the weight of the product when filled with water without breakage or damage to the handle, its securing means, or that portion of the enclosure to which it is attached, for a period of 1 minute. The load shall be uniformly applied over a 76 mm (3 in) width at the center of the handle, without clamping. The load shall be gradually applied so that the total test load will be reached in 5 – 10 seconds.

13.2 If more than one handle is furnished, the force shall be distributed evenly between the handles so that each handle will carry a load proportional to the load it would carry when the product is lifted by the handles. If the product has more than one handle, but can be carried by only one handle at a time, each handle shall support the entire test load.

14 Strength of Mounting

14.1 The mounting means of a product intended for wall or ceiling mounting shall withstand a force equal to four times the weight of the product without breakage of or damage to the mounting means, its securing means, and that portion of the product to which it is attached. Results shall be acceptable if the product and mounting systems remain in place with no evidence of damage or permanent distortion.

14.2 The product shall be mounted in accordance with the manufacturer's installation instructions, using the hardware and construction as described. The force – four times the weight of the product, or the product itself plus three times its own weight – shall be applied through a 76 mm (3 in) wide strap at the dimensional center of the product and shall be increased in a 5 – 10 second interval until a load equal to the weight of the product plus three times its weight, but not less than 4.5 kg (10 lbs), is applied to the mounting system. The load shall be sustained for 1 min.

14.3 With reference to Clause 14.2, if no wall constructions are specified, 3/8-inch trade size plaster board (dry wall, gypsum board) on nominal 2 by 4 inch wood studs spaced on 406 mm (16 in) centers shall be used as the support surface. The hardware shall be applied as specified in the instructions, and if not otherwise indicated, the securing screws shall be positioned between the studs and secured into the plasterboard. An adjustable product shall be adjusted to the position that will give the maximum projection from the wall.

15 Mechanical Assembly

15.1 A product shall be assembled in accordance with the requirements of this Clause so that it will not be adversely affected by the vibration of intended operation.

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

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

a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to rotate the switch during intended operation of the switch;

b) Means for mounting the switch make it unlikely that operation of the switch will loosen it;

c) Spacings are not reduced below the minimum acceptable values if the switch rotates; and

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d) Intended 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 light in which the lamp is sealed in by a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

15.3 Means for preventing the rotation mentioned in Clause 15.2 shall consist of more than friction between surfaces; for example, a lock washer may be used to prevent turning of a small stem-mounted switch or other device having a single-hole mounting means.

15.4 Uninsulated live parts and wiring shall be kept away from moving parts such as relays and contactors by clamping, routing, or equivalent means that will provide permanent separation.

15.5 An uninsulated live part, including a terminal, shall be secured to the supporting surface by a method other than friction between surfaces so that it will not be likely to turn or shift in position if such motion may result in the reduction of spacings below the minimum acceptable values. The security of contact assemblies shall be such that their continued alignment will be maintained.

15.6 Friction between surfaces shall not be the sole means of reducing the likelihood of shifting or turning of live parts, but a lock washer shall be acceptable.

16 Liquid-Containing Parts

16.1 If the deterioration or breakage of any part that contains, conducts, or otherwise contacts a liquid can result in a risk of fire, electric shock, or injury to persons, the part shall be resistant to the liquid under all conditions of use. See Liquid-Container Test, Clause 68.

16.2 In addition to complying with Clause 16.1, a polymeric material used to support electrodes in liquid-containing cylinders shall be subjected to the tests specified in (a) to (e):

a) A flammability test in accordance with the method for HB materials in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and HB materials in the CSA Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA-C22.2 No 0.17;

b) A mold stress relief test, as specified in Clause 73;

c) High-voltage-arc tracking, in accordance with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and CAN/CSA-C22.2 No. 0.17;

Exception: This test need not be conducted if a 12.7 mm (1/2 in) spacing is provided between live parts.

d) Comparative tracking index (CTI) under moist conditions, in accordance with the requirements in UL 746C, and CAN/CSA-C22.2 No. 0.17. The CTI value shall be a minimum of 100 V;

e) Relative thermal index (RTI), in accordance with the requirements in UL 746C and CAN/CSA-C22.2 No. 0.17. The material shall not exceed the general use temperature for required properties.

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17 Protection Against Corrosion

17.1 If corrosion of a part may result in a risk of fire, electric shock, or injury to persons, such a part shall be plated, painted, or the equivalent. Phosphate treatment with an oil or wax coating may be used for protecting magnets and armatures. Oil treatment may be used for steel springs. Stainless steel shall be acceptable without additional protection if it is polished or treated when necessary.

17.2 Metals shall be used in combinations that are galvanically compatible if galvanic action may adversely affect any cabinet, enclosure, or other parts.

17.3 Each hinge and other attachment shall be resistant to corrosion.

18 Cord-Connected Products

18.1 Equipment other than plenum or duct-mounted humidifiers may be cord connected if:

a) The voltage rating does not exceed 250 V;

b) It will start and operate as intended from a circuit with a 30 A overcurrent protection (see Starting Test, Clause 55); or

c) The marked rating does not exceed 24 A.

18.2 Plenum or duct-mounted humidifiers may be cord connected if:

a) The voltage rating does not exceed 150 V;

b) The current rating does not exceed 12 A;

c) A branch circuit overcurrent protection of not more than 15 A is required for satisfactory starting and operating; and

d) The design does not require that field wiring connections operating at above 30 V shall be made at the time of installation to a furnace control or to a control for the humidifier.

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19 Permanently Connected Products

19.1 A product intended for permanent connection to the power-supply circuit shall have provision for connection of one of the wiring systems acceptable for the product, in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part 1, C22.1.

19.2 Equipment shall have provision for the connection of conduit or conduits of a size suitable for the supply circuit conductors needed to connect the unit in accordance with Table 2, Allowable Ampacities for Not More Than 3 Copper Conductors in Raceway or Cable, and Table 4, Allowable Ampacities for Not More Than 3 Aluminum Conductors in Raceway or Cable, in the Canadian Electrical Code, Part 1, C22.1, and Table 310-16, Allowable Ampacities of Insulated Conductors Rated 0 through 2000 Volts, 60°C through 90°C (140°F through 194°F) Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried) Based on Ambient Temperatures of 30°C (86°F), in the National Electric Code, ANSI/NFPA 70, basing the minimum conductor size on 125 percent of the rated current of the product. Please see Tables 5 and 6 for further information. It is assumed that aluminum conductors may be used, unless the product is marked in accordance with Clause 78.2.

19.3 A metal plate to which conduit is to be attached in the field shall be not less than 0.78 mm (0.0307 in) thick if uncoated steel, not less than 0.88 mm (0.0346 in) thick if galvanized steel, and not less than 1.14 mm (0.045 in) thick if nonferrous metal.

19.4 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those required by Clause 42, Spacings.

19.5 A single field wiring opening may be provided for hazardous voltage and extra-low-voltage field supply circuits, and the construction of the equipment at the point where the conduit of the supply is attached shall be such that supply conductors can be installed in compliance with the requirements of Clause 29, Separation of Circuits.

19.6 Equipment which incorporates more than one independent internal circuit, and is designed for connection to more than one source of electrical power supply, shall have each internal circuit provided with means for connection to the supply, and shall be marked in accordance with Clause 75.29.

19.7 An outlet or terminal box in which connections to the power supply circuit will be made shall be located so that, after the product has been installed as intended, such connections will be readily accessible for inspection.

19.8 No electrical components shall be mounted on a part such as the cover of a wiring terminal compartment that must be removed to make or inspect field-wiring connections.

19.9 The space provided at terminals or leads intended for the connection of supply conductors, or other conductors to be connected at the time of installation, shall be sufficient for acceptable installation as defined in Clause 19.10, including the accommodation of the necessary splices.

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19.10 An acceptable installation shall:

a) Be possible using ordinary tools suitable for the installation; and

b) Not require installed conductors to be forced into contact with uninsulated live parts, or with noncurrent-carrying parts likely to be grounded.

A trial installation may be performed to determine compliance with these requirements.

19.11 The wiring terminal compartment shall incorporate suitable means for the connection thereto of a grounding conductor.

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

19.13 Wiring space or other compartments intended to enclose wires shall be free of any sharp edge, burr, fin, moving part, or the like that may damage the conductor insulation.

19.14 If field-wiring connections are to be made to a motor terminal compartment, the compartment shall comply with the requirements in the Standard for Electric Motors, UL 1004, and the CSA Standard for Motors and Generators, C22.2 No. 100.

20 Leads and Terminals

20.1 A terminal for field adjustment, such as a voltage-tap change terminal, is not considered to be a field-wiring terminal. A wire intended for connection to a field-adjustment terminal and its method of connection, such as a pressure-terminal connector, soldered loop, crimped eyelet, or the like, shall be factory assembled and provided as part of the product.

20.2 A field-wiring terminal shall be provided with a pressure-terminal connector, firmly bolted or held by a screw.

Exception: A wire-binding screw may be employed at a terminal intended to accommodate a 5.3 mm^2 (No. 10 AWG) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

20.3 A wiring terminal shall accommodate connection of a supply conductor having an ampacity of at least 125 percent of the rated current of the product in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part 1, C22.1.

20.4 Wiring terminals to which supply conductors will be attached in the field shall be prevented from turning. The use of lockwashers shall not be considered an effective way to prevent turning of terminals.

20.5 A wire-binding screw shall thread into metal.

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20.6 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

Exception: A No. 8 screw may be used at a terminal intended only for the connection of a 2.1 mm^2 (No. 14 AWG) or smaller conductor, and a No. 6 screw may be used at a terminal intended for connection of a 1.3 or 0.82 mm^2 (No. 16 or 18 AWG) conductor only.

20.7 2.1 mm^2 (No. 14 AWG) is the smallest size of conductor that shall be used for branch-circuit wiring, and thus is the smallest conductor that is to be anticipated at a terminal for connection of a branch-circuit conductor.

20.8 The terminals of a control may be employed for the connection of supply-circuit conductors provided that they comply with Clause 20.6.

20.9 A terminal plate tapped for a wire-binding screw shall be of metal at least 0.76 mm (0.030 in) thick. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

20.10 A wire connector may thread into a terminal plate if the threads are not stripped by applications of the torque specified in Table 7 to the wire connector.

20.11 Upturned lugs or a copper washer shall be capable of retaining a supply conductor under the head of the screw or washer when the supply conductor is sized for the ampacity indicated in Clause 20.3.

20.12 If leads are provided instead of terminals for connection to supply circuit conductors, they shall be not smaller than 0.82 mm^2 (No. 18 AWG), nor less than 152 mm (6 in) in length.

Exception: The lead may be less than 152 mm long if it is evident that the use of a longer lead may result in a risk of fire or electric shock.

20.13 A pigtail lead shall not be more than two AWG wire sizes smaller than a copper supply conductor to which it is to be connected.

20.14 It shall be assumed that wire having the specified temperature rating will be installed for the power-supply conductors to a product marked in accordance with Clause 78.1. Otherwise, it shall be assumed that 75°C (167°F) wire will be used.

20.15 Field-wiring terminals shall be acceptable for copper supply conductors or for either aluminum or copper supply conductors, in accordance with the marking required by Clause 78.2.

20.16 The distance between a pressure terminal connector intended for field wiring and the wall of an enclosure toward which the conductor is directed or through which the conductor may pass shall be as specified in Table 8.

Exception: Spacings may be less where a wall or other obstruction lies outside the area occupied by a conductor that is bent or deflected to a radius not less than the distance specified in Table 8.

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20.17 A permanently connected product intended for connection to a grounded power-supply conductor and employing a lampholder of the screw-shell type, a single-pole switch, or a single-pole automatic control shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The identified terminal or lead shall be connected to the screw shell of each lampholder and shall not be connected to any single-pole switch or single-pole overcurrent protective device other than automatic controls without a marked ″off″ position.

20.18 A terminal intended for the connection of a grounded power-supply conductor shall be made of, or plated with, a metal that is substantially white in color, or be identified by the word ″white″ or the letter ″W″ marked next to the terminal. The terminal shall be readily distinguishable from the other terminals, or proper identification of the terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

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

20.19 revised May 12, 2006

21 Flexible Cords

21.1 A cord-connected product shall be provided with a flexible cord, 1.5 – 3.0 m (5 – 10 ft) long, and an attachment plug cap, for connection to the power-supply circuit.

21.2 The flexible cord shall have a voltage rating of not less than the rated voltage of the product, and it shall have an ampacity not less than the current rating of the product marked as specified in Clause 74.1.1.

21.3 The flexible cord may be attached to the product permanently, or it may be in the form of a separate cord set with means for connection to the product. If the latter construction is used, the product shall not be provided with terminal pins that will accommodate a standard flatiron or appliance plug.

21.4 The flexible cord shall be of a type as specified in Table 9, or of a type equally serviceable for the application.

21.5 An attachment plug shall have a current rating of not less than 125 percent of the rated current of the product and a voltage rating equal to the rated voltage of the product. If the product is adaptable for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided shall be acceptable for the voltage for which the product is connected when shipped from the factory.

21.6 If the equipment is intended to be grounded as specified in Grounding, General, Clause 31.1, the supply cord shall have an additional conductor for grounding purposes that is:

a) Colored green or green/yellow;

b) Terminated in a grounding pin or blade in the attachment-plug; and

c) Connected to the equipment so that it will comply with Clause 31.1.

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