



UL 1017

STANDARD FOR SAFETY

Vacuum Cleaners, Blower Cleaners,
and Household Floor Finishing
Machines

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UL Standard for Safety for Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines,
UL 1017

Tenth Edition, Dated September 15, 2017

Summary of Topics

This revision of ANSI/UL 1017 dated March 14, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

As noted in the Commitment for Amendments statement located on the back side of the title page, ULSE and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated March 14, 2023 will not be jointly issued by ULSE and CSA as these revision pages only address UL ANSI approval dates.

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 requirements are substantially in accordance with Proposal(s) on this subject dated January 20, 2023.

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CSA Group
CSA C22.2 No. 243-17
Sixth Edition



ULSE Inc.
UL 1017
Tenth Edition

Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines

September 15, 2017

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ANSI/UL 1017-2017 (R2023)

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This ANSI/UL Standard for Safety consists of the Tenth Edition including revisions through March 14, 2023. The most recent designation of ANSI/UL 1017 as a Reaffirmed American National Standard (ANS) occurred on March 14, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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PREFACE

This is the harmonized CSA Group, and ULSE standard for Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines. It is the sixth edition of CAN/CSA-C22.2 No. 243, and the tenth edition of UL 1017. This edition of CAN/CSA-C22.2 No. 243 supersedes the previous edition(s) published in 2015. This edition of UL 1017 supersedes the previous edition(s) published in 2015.

This harmonized standard was prepared by the CSA Group and ULSE. The efforts and support of the Vacuum Cleaner industry of both the USA and Canada are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Integrated Committee on Electrical Motor- and Battery-Operated Cleaning Appliances for Industrial and Commercial Use, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety,, and has been formally approved by the CSA Technical Committee.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

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 is published as an identical standard for CSA Group and ULSE.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

Reasons for Differences From IEC

There is no corresponding IEC standard.

Interpretations

The interpretation by the standards development organization 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 standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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Vacuum Cleaners, Blower Cleaners, And Household Floor Finishing Machines

1 Scope

1.1 This Standard applies to motor-operated vacuum cleaners and blower cleaners, floor sweepers, and to household use floor finishing machines to be employed in accordance with C22.1, C22.2 No. 0, and ANSI/NFPA 70.

1.2 These requirements cover:

- a) Household, commercial, and coin-operated vacuum cleaning machines and blower cleaners, intended for indoor or outdoor use or both;
- b) Household, commercial, and coin-operated wet pick-up, dry pick-up, permanently mounted, portable, and central vacuum cleaners and blower cleaner systems;
- c) Household electrically powered floor finishing machines, including floor polishers, floor scrubbers, floor sanders, rug shampooers, rug and floor washers, and similar machines;
- d) Appliances covered by this Standard that are marked as being provided with double insulation and that employ double insulation in place of grounding in accordance with the Exception to Clause [4.16.1](#);
- e) Portable rechargeable battery-powered appliances for indoor or outdoor use with rechargeable non-user and user-replaceable batteries; see Clause [7](#);
- f) Current-carrying hoses for use with vacuum cleaner/motorized nozzle combination appliances intended for household, dry pick-up, indoor use; see Clause [8](#);
- g) Current-carrying hoses for use with motorized nozzles intended for use with central vacuum cleaning systems intended for household, dry pick-up, indoor use; see Clause [8](#);
- h) Wet pick-up current-carrying hoses for use with household, indoor use carpet cleaning equipment; see Clause [8](#);
- i) Grounded current-carrying hoses for use with motorized nozzles intended for household indoor use; see Clause [8](#);
- j) Electrified wall valves for connection of current-carrying hose/motorized nozzle combinations for central vacuum cleaning systems intended for household use; see Clause [8](#);
- k) Household, indoor use, wet/dry vacuum cleaning machines with a steam-cleaning attachment (such as a vacuum provided with a steam generator in the nozzle), where the vacuum is the prominent feature of the appliance as evidenced by the electrical rating of the vacuum function being greater than the electrical rating of the steam-cleaning function; see also Clause [2.3.3](#). A steam cleaner provided with a vacuum attachment, where the steam-cleaning function is the prominent feature, is covered under the requirements of C22.2 No. 64 and UL 499; and
- l) Household and commercial floor sweepers.
- m) Vacuum cleaners intended for installation in recreational vehicles (R/V) or marine vessels;
- n) Appliances powered through a vehicle battery adapter.

1.3 These requirements do not cover appliances rated more than 250 V. An appliance that utilizes some other source of energy, such as gas or steam, in addition to electric energy is to be investigated under these requirements and under such additional requirements as are applicable to the appliance under consideration.

1.4 These requirements do not cover appliances for use in locations such as those areas of hospitals, laboratories, institutions, and the like where dispersion of pathological, chemical, physical, radioactive or other agents could produce a risk to health. Appliances intended for use in such locations are investigated under these requirements and under such additional requirements as are applicable to the appliance, with appropriate consideration being given to the specific intended use.

1.5 These requirements apply only to a specific type or types of appliances, such as a vacuum cleaner or floor finishing machine, if the requirement is so identified by specific reference to the type or types involved. Absence of such specific reference or use of the term "appliance" indicates that the requirement applies to all appliances covered by this standard.

1.6 Internal-combustion engine powered floor cleaning machines for industrial/commercial use, such as floor buffers, scrubbers, sweepers, extractors, and polishers, are covered under UL 558.

1.7 These requirements do not cover machines that generate pressure in excess of 2.5 MPa (360 psi).

2 General

2.1 Attachments

2.1.1 A functional attachment that is recommended, made available, or packaged with an appliance by the manufacturer for use with an appliance shall be included in the investigation of the appliance.

Exception No. 1: A non-electrical attachment, such as a crevice tool, an upholstery brush, or the like, that has no driven parts and is intended to facilitate a cleaning operation without the use of a liquid need not be investigated.

Exception No. 2: A non-electrical attachment that has no driven parts and is intended to facilitate a cleaning operation with the use of a liquid need not be investigated when intended for use with a wet pick-up vacuum cleaner or household extractor.

2.1.2 An electrical attachment provided with line-voltage electrical contacts on the underside of the attachment and in close proximity to the surface to be cleaned shall comply with the following:

a) Based on the anticipated build-up of dust or dirt on the bottom of the attachment and the possibility of a conductive path being established between the electrical contacts, there shall not be an increase in the risk of fire due to the shorting of the electrical contacts. The attachment shall be tested as described in the abnormal operation – shorted electrical contact test, Clause [5.10.3](#).

b) During the anticipated cleaning of the attachment, there shall not be an increase in the risk of electric shock to the user. The attachment, while connected to the appliance, shall be tested as described in the cleaning test, Clause [5.12.9](#).

c) If the electrical attachment is intended to be inserted into mating electrical contacts (such as the contacts of a motorized brush), the mating of which can energize a load (such as the brush motor or relay coil), the mating electrical contacts on the attachment shall have suitable voltage and current ratings, and be suitably rated to make and break the particular load in accordance with C22.2 No. 182.1 and UL 1977.

d) The applicable severe conditions (see Clause [5.21.5](#)) and abnormal operation (see Clause [5.21.7](#)) tests shall be conducted with and without the electrical attachment connected to the appliance as intended.

2.1.3 A vacuum cleaner provided with a steam-cleaning attachment shall be evaluated and tested as a wet pick-up type vacuum.

2.1.4 A non-electrical container recommended by the manufacturer for use with a household wet/dry pick-up appliance, but not provided by the appliance manufacturer, shall be included in the investigation of the appliance. The appliance shall be designed so that it can be affixed or mounted to the container by the user without the use of tools. The appliance shall meet the applicable enclosure requirements of Clauses [4.2](#), [4.20.3](#), and [5.21](#) without the container attached. See also Clauses [11.1.5](#), [11.4.27](#), [12.2.7](#)(m), and [12.5.17](#).

2.2 Fluids – Proprietary

2.2.1 For a household extraction-type floor cleaning machine that is intended to be used with a proprietary fluid in accordance with Exception No. 3 to Clause [5.12.8.1.2](#), the manufacturer shall package the proprietary fluid with the appliance. If the appliance is intended for use with more than one proprietary fluid, the manufacturer shall package at least one of the proprietary fluids with the appliance.

Exception No. 1: If an attachment is recommended for use with an appliance, but is not packaged with the appliance, the proprietary fluid shall be included in the appliance packaging, or shall be included in the attachment packaging. See Clauses [2.1.1](#), [11.1.5](#), [12.5.7](#), and [12.7.2](#).

Exception No. 2: If an attachment and proprietary fluid is recommended for use with an extraction-type carpet cleaning machine, but the attachment and fluid are not packaged with the machine, and the attachment and fluid are packaged separately from each other, the following shall apply. See Clauses [2.1.1](#), [11.1.5](#), [12.5.7](#), and [12.7.2](#).

a) The household extraction-type floor cleaning machine shall be packaged with at least one cleaning fluid intended for the primary cleaning purpose of the machine. For example, a carpet cleaning machine shall be packaged with at least one carpet cleaning fluid.

b) The instructions shall instruct the user how to obtain the hard surface attachment and proprietary fluid.

2.3 Instructions provided with the appliance

2.3.1 A copy of the operating, user-maintenance, and other instructions intended to accompany an appliance as produced shall be used as a guide in the examination and test of the appliance. For this purpose, a draft copy is sufficient and a final printed copy is not required.

2.3.2 The instructions provided with an appliance shall include such directions and information as deemed by the organization responsible for the appliance to be necessary to cover the operation, use and maintenance of the appliance, and shall comply with the requirements for instruction manuals specified in Clause [12](#).

2.3.3 For a vacuum cleaning machine provided with a steam-cleaning attachment, the instruction manual shall indicate the appliance is primarily a vacuum cleaner with a steam-cleaning feature.

2.4 Secondary circuits

2.4.1 Annex D provides guidance for establishing various types of isolated secondary circuits and methods of evaluation applicable to each type of secondary circuit. This Annex does not supersede the requirements as specified in the body of this standard.

2.5 Equipment for recreational vehicle or marine vessel installation

2.5.1 A fixed or stationary vacuum cleaner intended for installation in recreational vehicles (R/V) or marine vessels shall be evaluated to the additional requirements in Clauses [4.3.2.1](#), [4.3.2.2](#), [4.4.5](#), [4.5.5.1.9](#), [5.19.6](#), [5.19.7](#), [5.19.8](#), [11.4.33](#), [11.4.34](#), [11.4.35](#), [12.5.20](#) and [12.5.21](#) as applicable.

2.6 Units of measurement

2.6.1 The values given in SI (metric) units shall be normative. Any other values given shall be for information purposes only.

2.7 Reference publications

2.7.1 Where reference is made to any Standards, such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified.

CSA Group Standards

C22.1

Canadian Electrical Code, Part I

C22.2 No. 0

General Requirements – Canadian Electrical Code, Part II

C22.2 No. 0.4

Bonding of electrical equipment

C22.2 No. 0.15

Adhesive Labels

C22.2 No. 0.17

Evaluation of Properties of Polymeric Materials

C22.2 No. 0.2

Insulation Coordination – General Instruction No 1

C22.2 No. 1

Audio, Video, and Similar Electronic Equipment

C22.2 No. 5

Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures

C22.2 No. 8

Electromagnetic Interference (EMI) Filters

C22.2 No. 12

Portable Luminaires

C22.2 No. 18.1
Metallic Outlet Boxes

C22.2 No. 18.2
Nonmetallic Outlet Boxes

C22.2 No. 18.3
Conduit, Tubing, and Cable Fittings

C22.2 No. 18.5
Positioning Devices

C22.2 No. 21
Cord Sets and Power-Supply Cords

C22.2 No. 24
Temperature-Indicating and Regulating Equipment

C22.2 No. 38
Thermoset-Insulated Wires and Cables

C22.2 No. 42
General Use Receptacles, Attachment Plugs, and Similar Wiring Devices

C22.2 No. 42.1
Cover Plates for Flush-Mounted Wiring Devices

C22.2 No. 43
Lampholders

C22.2 No. 49
Flexible Cords and Cables

C22.2 No. 55
Special Use Switches

C22.2 No. 64
Household Cooking and Liquid-Heating Appliances

C22.2 No. 65
Wire Connectors

C22.2 No. 72
Heating Elements

C22.2 No. 75
Thermoplastic-Insulated Wires and Cables

C22.2 No. 77
Motors With Inherent Overheating Protection

C22.2 No. 100
Motors and Generators

C22.2 No. 107.1

General-Use Power Supplies

C22.2 No. 127

Equipment and Lead Wires

C22.2 No. 144.1

Ground-Fault Circuit-Interrupters

C22.2 No. 153

Quick-Connect Terminals

C22.2 No. 158

Terminal Blocks

C22.2 No. 182.1

Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type

C22.2 No. 182.3

Special Use Attachment Plugs, Receptacles, and Connectors

C22.2 No. 188

Splicing Wire Connectors

C22.2 No. 190

Capacitors and Power Factor Correction

C22.2 No. 197

PVC Insulating Tubing

C22.2 No. 198.1

Extruded Insulating Tubing

C22.2 No. 198.3

Coated Electrical Sleeving

C22.2 No. 210

Appliance Wiring Material Products

C22.2 No. 223

Power Supplies with Extra-Low-Voltage Class 2 Outputs

C22.2 No. 235

Supplementary Protectors

C22.2 No. 248.00 Series

Low Voltage Fuses

C22.2 No. 4248 Series

Fuseholders – Part 1: General Requirements

C22.2 No. 66.1

Low-Voltage Transformers – Part 1: General Requirements

C22.2 No. 66.2

Low-Voltage Transformers – Part 2: General Purpose Transformers

C22.2 No. 66.3

Low-Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

CAN/CSA-E60691

Thermal-Links, Requirements and Application Guide

CAN/CSA-E60730-1

Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements

CAN/CSA-E60730-2-9

Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls

C22.2 No. 60950-1

Information Technology Equipment – Safety – Part 1: General Requirements

C22.2 No. 61058-1

Switches for Appliances, Part 1: General Requirements

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Fixture Wire

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Thermoplastic-Insulated Wires and Cables

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Extruded Insulating Tubing

UL 244A

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UL 310

Electrical Quick-Connect Terminals

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Cord Reels

UL 486A-486B
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UL 486C
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Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

UL 489
Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 496
Lampholders

UL 498
Attachment Plugs and Receptacles

UL 499
Electric Heating Appliances

UL 510
Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

UL 514A
Metallic Outlet Boxes

UL 514B
Conduit, Tubing, and Cable Fittings

UL 514C
Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL 514D
Cover Plates for Flush-Mounted Wiring Devices

UL 558
Industrial Trucks, Internal Combustion Engine-Powered

UL 635
Insulating Bushings

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Polymeric Materials – Short Term Property Evaluations

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Polymeric Materials – Long Term Property Evaluations

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Thermally Protected Motors

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Electronically Protected Motors

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UL 1059

Terminal Blocks

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Supplementary Protectors for Use in Electrical Equipment

UL 1283

Electromagnetic Interference Filters

UL 1310

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UL 60384-14

Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains

UL 1439

Tests for Sharpness of Edges on Equipment

UL 1441

Coated Electrical Sleeving

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Systems of Insulating Materials – General

UL 1449

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Positioning Devices

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Optical Isolators

UL 1676

Conductive-Path and Discharge-Path Resistors for Use in Radio-, Video-, or Television-Type Appliances

UL 1681

Wiring Device Configurations

UL 1699

Arc-Fault Circuit-Interrupters

UL 1977

Component Connectors for Use in Data, Signal, Control and Power Applications

UL 2595

General Requirements for Battery-Powered Appliances

UL 4248-1

Fuseholders – Part 1: General Requirements

UL 5085-1

Low-Voltage Transformers – Part 1: General Requirements

UL 5085-2

Low-Voltage Transformers – Part 2: General Purpose Transformers

UL 5085-3

Low-Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

UL 6059

Particular Requirements for Switches for Tools

UL 8750

Light Emitting Diode (LED) Equipment For Use In Lighting Products

UL 60691

Thermal-Links—Requirements and Application Guide

UL 60730-1

Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements

UL 60730-2-7

Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches

UL 60730-2-9

Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls

UL 60950-1

Information Technology Equipment – Safety – Part 1: General Requirements

UL 61058-1

Switches for Appliances, Part 1: General Requirements

ASTM Standards

ANSI/ASTM E230/E230M

Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

ASTM B117

Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM F 655

Standard Specification for Test Carpets and Pads for Vacuum Cleaner Testing

Code of Federal Regulations

CFR 21

Performance Standards for Light-Emitting Products, Part 1040, Chapter 1, Subchapter J, Radiological Health

IEC Standards

IEC 60320

Appliance Couplers for Household and Similar General Purposes

IEC 60417

Graphical Symbols for Use on Equipment

IESNA Standards

ANSI/IESNA RP-27.1

Recommended Practice for Photobiological Safety for Lamps and Lamp Systems-General Requirements

ANSI/IESNA RP-27.3

Recommended Practice for Photobiological Safety for Lamps – Risk Group Classification and Labeling

ISO 7000

Graphical Symbols for Use on Equipment – Registered Symbols

ISO 7010

Graphical Symbols – Safety Colours and Safety Signs – Registered Safety Signs

ISO 12100

Safety of Machinery – General Principles for Design – Risk Assessment and Risk Reduction

ISO 13849-1

Safety of Machinery – Safety Related Parts of Control Systems – Part 1: General Principles for Design

ISO 16000-9

Indoor Air – Part 9: Determination of the Emission of Volatile Organic Compounds from Building Products and Furnishing – Emission Test Chamber Method

ISO 28360

Information Technology – Office Equipment – Determination of Chemical Emission Rates from Electronic Equipment

NEMA Standards

ANSI/NEMA WD 6

Wiring Devices

NFPA Standards

ANSI/NFPA 70

National Electrical Code

3 Definitions

3.1 The following definitions apply in this Standard:

3.2 Accessible part or surface – A part or surface subject to contact by persons under any condition of operation or user function. In a determination of whether a live or noncurrent-carrying part or surface is accessible through an opening in the enclosure to such contact, the criteria specified in accessibility of live parts, Clause [4.2.5](#), applies.

3.3 Appliance coupler – A single-outlet, female contact device for attachment to a flexible cord as part of a cord set (detachable power-supply cord) to be connected to an appliance inlet (motor attachment plug).

3.4 Appliance inlet (motor attachment plug) – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

3.5 Appliance (flatiron) plug – An appliance coupler type of device having a cord guard and a slot configuration specified for use with heating or cooking appliances.

3.6 Automatically controlled – An appliance is considered to be automatically controlled if:

- a) The repeated starting of the appliance, beyond one complete predetermined cycle of operation to the point where some form of limit switch opens the circuit, is independent of any manual control;
- b) During any single predetermined cycle of operation, the motor is caused to stop and restart one or more times;
- c) Upon energizing the appliance, the initial starting of the motor may be intentionally delayed beyond normal, conventional starting; or
- d) During any single predetermined cycle of operation, automatic changing of the mechanical load may reduce the motor speed sufficiently to reestablish starting-winding connections to the supply circuit.

3.7 Automatic battery-powered vacuum cleaner (robot vacuum) – An automatically controlled vacuum intended for household, dry pick-up, indoor use typically intended for unattended automatic operation and capable of autonomous motion. These appliances are also known as robot vacuums. The automatic operation (auto-mode) is considered to be the time when the robot vacuum is performing its programmed tasks through continuous program execution. This type of vacuum consists of the robot battery-powered vacuum part and a docking station. The vacuum is typically provided with a motor-driven brush for cleaning and motor-driven wheels for movement, sensing devices/controls to determine the vacuum's location, and sensing devices/controls to detect obstructions and stairs.

3.7.1 Automotive vacuum cleaners for public use – Vacuum cleaners provided for the use of the general public without restriction in locations such as filling stations and car washes that are either fixed or stationary installation.

3.8 Basic insulation – The insulation in contact with live (current-carrying) parts to provide basic protection against the risk of electric shock.

3.9 Control, automatic action – A control in which at least one aspect is non-manual.

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

3.11 Control, manual – A device that requires direct human interaction to activate or reset the control.

3.12 Control, operating – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, an electronic motor ON/OFF control, the failure of which another layer of protection (e.g., a warning marking on a motorized brush) would reduce the risk of electric shock, fire, or injury to persons, is considered an operating control.

3.13 Control, protective – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire, or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, an interlock control, a motor overload protector, a thermal cutout/limiter, or a thermostat intended to limit temperatures in the end product, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. During the evaluation of the protective control / circuit, the protective functions are verified under normal and single-fault conditions of the control.

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

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

3.16 Cord connector – A female contact device wired on flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or, as an appliance coupler, to an equipment inlet.

3.17 Double insulation – An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and so arranged that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, and the like) to the same degree. See [Figure 13](#).

3.18 Extra-low voltage circuit – A circuit involving a peak open-circuit potential of not more than 42.4 V (30 Vrms) for dry applications and 21.2 V (15 Vrms) for wet applications, supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current is not considered to be an extra-low voltage circuit.

3.18.1 Fixed equipment – Any equipment or appliance that is intended to be permanently connected electrically to the wiring system.

3.19 Floor sweeper – A portable, indoor-use, household or commercial, dry pick-up type appliance that is intended to sweep up dirt or debris from a bare floor surface or carpeted floor surface using a motor-driven rotating brush, without the use of suction. As the user moves the floor sweeper along the floor surface, the rotating brush sweeps up the dirt from the floor and gathers it into an on-board dirt container. This dirt container may be removable from the appliance so the user can empty it when full.

3.20 Hard surface – Any surface that is not carpeted or upholstered.

3.21 Household extraction-type floor cleaning machine – Either a hard surface cleaning machine, a self-contained carpet cleaning machine, or a machine that can clean both hard surfaces and carpeted surfaces. These machines apply a cleaning solution to the surface to be cleaned and then extract the solution.

3.22 Line-voltage circuit – A circuit involving a potential of not more than 600 V and having circuit characteristics in excess of those of an extra-low voltage circuit.

3.23 Live (current-carrying) part – A part that is conductively connected to a line-voltage circuit. See Clause [3.22](#).

3.24 Measurement indication unit (MIU) – The unit used in measuring leakage current as defined in UL 101.

3.25 Noncurrent-carrying metal part – A metal or other electrically conductive part, accessible or inaccessible, that is not conductively connected to a live part.

3.25.1 Portable appliance – An appliance that is easily carried or conveyed by hand, and is provided with a power-supply cord for connection to the supply circuit.

3.26 Power switch – A switch that provides ON/OFF control for the following in (a) – (c) below. For an appliance provided with multiple switches that control the same loads, the power switch is considered to be the switch declared by the manufacturer to be the power switch and is accessible to the user during operation. If a motor is rated 1/3 hp or less, and the Clause [11.4.15](#) marking is included, the motor control switch is not considered a power switch.

- a) Portable appliances with a motor greater than 1/3 h;
- b) Stationary appliances with a motor greater than 1/8 h; or
- c) Motor controlling accessible moving parts capable of causing injury.

3.27 Proprietary fluid – An aqueous solution designated for use with a household extraction-type floor cleaning machine that is exclusively controlled by the same manufacturer as the appliance.

3.28 Reinforced insulation – An improved basic insulation system with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against a risk of electric shock as double insulation. It may consist of one or more layers of insulating materials.

3.29 Remotely controlled appliance – An appliance that is out of sight of the operator who is at the starting device.

3.30 Robot vacuum docking station – A cord-connected charging unit providing battery-charging capabilities to the automatic rechargeable battery-powered vacuum cleaner. This is the base unit in which the robot vacuum automatically returns, or is returned by the user, to charge the vacuum's battery.

3.31 Safety-critical function – Function(s) required by this standard, the loss of which would cause the appliance to function in such a manner as to expose the user to a risk that is in excess of the risk that is permitted by this end product standard under abnormal conditions.

3.31.1 Stationary equipment – Any equipment or appliance that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

3.31.2 Stand-alone product – A product or accessory that is intended to be sold separately and used in conjunction with other equipment based on the marked ratings, such as current-carrying hoses and motorized nozzles for use with central vacuum cleaning systems.

3.32 Supplementary insulation – An independent insulation provided in addition to the basic insulation to protect against a risk of electric shock in case of mechanical rupture or electrical breakdown of the basic insulation. An enclosure of insulating material may form a part or all of the supplementary insulation.

3.32.1 Utility vacuum cleaner – A portable, floor-supported, cord-connected dry or wet/dry vacuum cleaner having a nozzle separated from the cleaner housing by a hose intended primarily for use in garages and shops, and suitable for picking up larger debris.

3.33 Vehicle battery adapter – A power connector intended for insertion into a vehicle power port/receptacle to provide power to a device or appliance.

4 Construction

4.1 Components

4.1.1 General

4.1.1.1 Components shall comply with the safety requirements specified in the relevant CSA and UL standards as far as they reasonably apply, and to the extent that:

- a) The proper functioning of the component is required for the safety of the end-product; and
- b) The component itself does not increase the risk of fire or electric shock or personal injury when operated under either under normal use conditions or under the abnormal conditions described in this standard.

4.1.1.2 Components that are generally required to meet the safety requirements of the component standards in their entirety are specified in Clause [4.1.2](#); others are referenced throughout this end-product standard.

4.1.1.3 A component that is required by this standard to fulfill a particular referenced component standard shall:

- a) Be described within the scope of that standard;
- b) Be employed in the end product in a manner consistent with the intended use described in the component standard;
- c) Be used in accordance within its rating(s) established for the intended conditions of use or its established Conditions of Acceptability; and
- d) Additionally comply with the applicable requirements of this end product standard.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product;*
- b) Is superseded by a requirement in this standard; or*
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.*

4.1.2 Specific component requirements

4.1.2.1 A marking and labeling system shall comply with C22.2 No. 0.15 and UL 969 for the surface it is applied to, and to the environmental conditions consistent with the intended use of the product (e.g. indoor or outdoor).

4.1.2.2 A Class 2 power supply shall comply with:

- a) C22.2 No. 223 and UL 1310; or
- b) C22.2 No. 60950-1 and UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

4.1.2.3 A non-Class 2 power supply shall comply with:

- a) C22.2 No. 107.1 and UL 1012; or
- b) C22.2 No. 60950-1 and UL 60950-1.

4.1.2.4 Printed wiring boards, including the coatings, shall comply with C22.2 No. 0.17 and UL 796, and have a minimum HB flame rating. Those printed wiring boards providing direct support of live parts shall additionally comply with the direct-support requirements for insulating materials in C22.2 No. 0.17 and UL 746C.

Exception: A printed-wiring board in an extra-low voltage, non-safety circuit is not required to comply with the bonding requirements in C22.2 No. 0.17 and 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.

4.1.2.5 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1577. If considered necessary, the dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Clause [5.11](#) of this end product standard.

4.1.2.6 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with UL 1577. If considered necessary, the dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Clause [5.11](#) of this end product standard.

4.1.2.7 Component requirements are not specified for small electronic components on printed wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

4.1.2.8 General-purpose transformers shall comply with C22.2 No. 66.1 and UL 5085-1, and C22.2 No. 66.2 and UL 5085-2.

Exception: A transformer that is completely enclosed within the end product enclosure and the secondary circuit is inaccessible, 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. See Clause [5.32](#).

4.1.2.9 Class 2 and Class 3 transformers shall comply with C22.2 No. 66.1 and UL 5085-1, and C22.2 No. 66.3 and UL 5085-3.

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

4.2 Enclosures

4.2.1 Mechanical strength and flammability

4.2.1.1 The frame and enclosure of an appliance shall have the necessary strength and rigidity to resist the abuses likely to be encountered during normal service. The degree of resistance inherent in the unit shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects that alone or in combination constitute a risk of fire, electric shock, or injury to persons.

4.2.1.2 For an unreinforced, flat surface:

- a) Cast metal shall not be less than 3.2-mm (1/8-in) thick;
- b) Malleable iron shall not be less than 2.4-mm (3/32-in) thick; and
- c) Die-cast metal shall not be less than 2.0-mm (5/64-in) thick.

Exception No. 1: Metal of a lesser thickness but not less than 2.4, 1.6, and 1.2 mm (3/32, 1/16, and 3/64 in), respectively, may be acceptable provided the surface under consideration is:

- a) *Curved, ribbed, or otherwise reinforced to provide mechanical strength equivalent to that required; or*
- b) *Of size or shape that provides mechanical strength equivalent to that required.*

Exception No. 2: Metal of a lesser thickness may be employed if it complies with the physical abuse tests in Clause [5.19](#).

4.2.1.3 An enclosure of sheet metal shall be judged with respect to size, shape, thickness of metal, and acceptability for the application considering the intended use of the appliance. Sheet steel shall have a minimum thickness of 0.66 mm (0.026 in); aluminum shall have a minimum thickness of 0.91 mm (0.036 in); and copper or brass shall have a minimum thickness of 0.84 mm (0.033 in).

Exception: An area that is relatively small or a surface that is curved or otherwise reinforced need not comply with this requirement if it complies with the physical abuse tests in Clause [5.19](#).

4.2.1.4 Factors that shall be taken into consideration when judging the acceptability of magnesium and nonmetallic material other than a polymeric material are resistance to:

- a) Mechanical damage;
- b) Impact;
- c) Moisture absorption;
- d) Combustion; and
- e) Distortion at temperatures to which the material may be subjected under conditions of normal or abnormal use.

4.2.1.5 Polymeric parts employed to enclose uninsulated live parts or insulated live parts whose insulation is less than 0.7 mm (0.028 in), or equivalent, shall be subjected to the tests in Clause [5.21](#) and shall have a flammability rating as noted below in accordance with C22.2 No. 0.17 and UL 94:

- a) 5 VA for a stationary appliance or an appliance that is permanently installed;
- b) HB minimum for a portable attended, intermittent duty, household appliance; and
- c) V2 minimum for an appliance other than as mentioned in (a) and (b).

Exception No. 1: In lieu of the required 5 VA flame rating for stationary or permanently installed appliances, the polymeric part may be subjected to the 127-mm (5-in) end-product flame test in accordance with UL 746C.

Exception No. 2: In lieu of the required HB flame rating for portable attended, intermittent duty, household appliances, the polymeric part may be subjected to the Needle Flame Test in accordance with C22.2 No. 0.17, or the 12-mm (0.47-in) or 20-mm (0.79-in) end-product flame test in accordance with UL 746C.

Exception No. 3: In lieu of the required V2 flame rating for appliances other than as mentioned in (a) and (b), the polymeric part may be subjected to the Needle Flame Test in accordance with C22.2 No. 0.17, or the 12-mm (0.47-in) or 20-mm (0.79-in) end-product flame test in accordance with UL 746C.

4.2.1.6 Polymeric parts employed to enclose insulated live parts [insulation 0.7-mm (0.028-in) thick minimum or equivalent], internal wiring and moving parts shall have a minimum flammability rating of HB in accordance with C22.2 No. 0.17 and UL 94, and shall be subjected to the mold stress-relief distortion test, Clause [5.21.3](#), and the impact test, Clause [5.21.4](#).

Exception: In lieu of the HB flame rating, the polymeric part may be subjected to the Needle Flame Test in accordance with C22.2 No. 0.17, or the 12-mm (0.47-in) or 20-mm (0.79-in) end-product flame test in accordance with UL 746C.

4.2.1.7 The requirements of Clauses [4.2.1.5](#), [4.2.1.6](#), and [4.2.2.1](#) are not applicable for coatings, such as paint, applied to the exterior surfaces of polymeric enclosure materials or to other external polymeric parts provided that the coating does not offer a continuous path for an internal flame to propagate externally.

4.2.1.8 With respect to the end-product flame tests referenced in Clauses [4.2.1.5](#), [4.2.1.6](#), and [4.2.2.1](#), if molded parts of the same polymeric material have different configurations, the end-product flame test shall be conducted on each configuration. The molded parts may have different internal bosses, projections, ribs, or other components mounted on the molded part that might have a potential negative or positive affect on the enclosure flame test results. If an engineering decision can be made that the two parts are very similar in construction, and one molded part can be considered to represent the other molded part, the end-product flame test may be waived. Different molding conditions of the molded parts is not the significant factor in determining if the end-product flame test has to be conducted in this type of situation.

4.2.2 Flammability of non-enclosure polymeric parts

4.2.2.1 Polymeric materials, including elastomeric materials, for use other than as described in Clauses [4.2.1.5](#) and [4.2.1.6](#), that are less than 12.7 mm (0.5 in) from an arcing part or less than 0.8 mm (0.03 in) from an uninsulated live part, shall have a minimum flammability rating of HB, or HBF for foamed materials, in accordance with C22.2 No. 0.17 and UL 94.

Exception No. 1: A small part whose maximum volume does not exceed 2 cm³ (0.12 in³) is not required to comply.

Exception No. 2: An external polymeric part that is detachable without the use of tools is not required to comply.

Exception No. 3: In lieu of the HB flame rating, the polymeric part may be subjected to the Needle Flame Test in accordance with C22.2 No. 0.17, or the 12-mm (0.47-in) or 20-mm (0.79-in) end-product flame test in accordance with UL 746C.

4.2.3 Openings in enclosures

4.2.3.1 The enclosure of a remotely or automatically controlled appliance shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the appliance is supported. See Clause [3.6](#) and [3.29](#).

4.2.3.2 The requirement in Clause [4.2.3.1](#) will necessitate the use of a barrier of noncombustible material:

a) Under a motor unless:

- 1) The structural parts of the motor or the appliance provide the equivalent of such a barrier;
- 2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance when the motor is energized under each of the following fault conditions:
 - i) Open main winding;
 - ii) Open starting winding;
 - iii) Starting switch short-circuited; and
 - iv) Capacitor of permanent-split capacitor motor short circuited – the short circuit shall be applied before the motor is energized, and the rotor shall be locked; or
- 3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will limit the temperature of the motor windings:
 - i) To 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle; and
 - ii) To 150°C (302°F) with the rotor of the motor locked; and

b) Under wiring, unless there is no evidence of a risk of fire as a result of the tests in Clause [5](#).

4.2.3.3 A switch, a relay, a solenoid, or the like in an appliance as specified in Clause [4.2.3.1](#) shall be individually and completely enclosed.

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

Exception No. 2: If malfunction of the component would not result in a risk of fire then the component need not be individually and completely enclosed.

Exception No. 3: If there are no openings in the bottom of the appliance enclosure then a switch, a relay, a solenoid or the like need not be individually and completely enclosed.

4.2.3.4 The barrier mentioned in Clause [4.2.3.1](#) shall be located as illustrated in [Figure 1](#), and shall have an area in accordance with that illustration. Openings for drainage, ventilation, or the like may be employed in the barrier, if such openings would not permit molten metal, burning insulation, or the like to fall on flammable material.

4.2.3.5 The construction of a vacuum cleaner intended to be exposed to rain shall comply with the water-spray test requirements specified in Clause [5.12.1](#).

4.2.3.6 The construction of a wet pick-up vacuum cleaner shall comply with the wet pick-up test requirements specified in Clause [5.12.2](#).

4.2.3.7 The door or cover of an enclosure shall be hinged or otherwise attached in an equivalent manner if it gives access to any overload protective device, the normal functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the protective device.

4.2.3.8 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight-fitting.

4.2.3.9 A portable cord-connected appliance that is provided with keyhole slots, notches, hanger holes, or the like for hanging on a wall shall be constructed so that the hanging means attached to the wall is not accessible when the appliance is placed on the hanging means as intended.

4.2.3.10 To determine whether an appliance complies with the requirement in Clause [4.2.3.9](#), any part of the enclosure or barrier that can be removed without the use of tools to gain access to the hanging means shall be removed.

4.2.3.11 An opening in an appliance provided for hanging the appliance shall be located or guarded so that a nail, hook, or the like does not displace a part that would create a risk of fire or electric shock and does not contact one of the following:

- a) An uninsulated live part;
- b) Magnet wire;
- c) Internal wiring;
- d) Moving parts; or
- e) Any other part likely to create a risk of fire or electric shock.

4.2.4 Adhesives used to secure parts

4.2.4.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in Clause [5.23](#).

4.2.4.2 The requirement in Clause [4.2.4.1](#) also applies to an adhesive used to secure a part, including a nameplate, that can, if loosened or dislodged:

- a) Make a live part accessible;
- b) Reduce spacings below the minimum specified values; or
- c) Expose a normally enclosed moving part.

4.2.5 Accessibility of live parts

4.2.5.1 To reduce the likelihood of unintentional contact that can involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b):

- a) For an opening that has a minor dimension (see Clause [4.2.5.5](#)) less than 25.4 mm (1 in), such a part or wire shall not be contacted by the probe illustrated in [Figure 2](#);
- b) For an opening that has a minor dimension of 25.4 mm (1 in) or more, such a part or wire shall be spaced from the opening as specified in [Table 1](#).

Exception: A motor employed in an appliance intended for commercial use other than one used in either a hand-held appliance or a hand-supported portion of an appliance need not comply with these requirements if it complies with the requirements in Clause [4.2.5.2](#).

4.2.5.2 With respect to a part or wire as mentioned in Clause [4.2.5.1](#) in an integral enclosure of a motor as mentioned in the exception to Clause [4.2.5.1](#):

- a) An opening that has a minor dimension (see Clause [4.2.5.5](#)) less than 19.1 mm (3/4 in) is acceptable if:
 - 1) Film-coated wire cannot be contacted by the probe illustrated in [Figure 3](#);
 - 2) An uninsulated live part cannot be contacted by the probe illustrated in [Figure 4](#);
- b) An opening that has a minor dimension of 19.1 mm (3/4 in) or more is acceptable if a part or wire is spaced from the opening as specified in [Table 1](#).

4.2.5.3 The probes illustrated in [Figure 2](#) – [Figure 4](#) shall be applied to any depth that the opening will permit and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in [Figure 2](#) – [Figure 4](#) shall be applied to any possible configuration and, if necessary, the configuration shall be changed after insertion through the opening.

4.2.5.4 The probes shall be used as measuring instruments to judge accessibility provided by an opening and not as instruments to judge the strength of a material.

4.2.5.5 With reference to the requirements in Clauses [4.2.5.1](#) and [4.2.5.2](#), the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

4.2.5.6 During the investigation of an appliance to determine whether it complies with the requirements in Clause [4.2.5.1](#) or [4.2.5.2](#), a part of the enclosure that can be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) shall be opened or removed.

4.2.5.7 The connection of an accessible part to live parts, including a supply conductor, to facilitate the discharge of static electricity shall comply with (a) – (d). To determine compliance with the remaining requirements in this Standard, the resistors and associated circuitry shall be investigated as live parts. The lead of the resistor connected to the accessible parts shall be investigated as a dead metal part:

- a) A minimum of two resistors connected in series shall be employed;
- b) The resistors shall comply with the applicable requirements in C22.2 No. 1 and UL 1676;

c) For the tests described in Clauses [5.3](#), [5.4](#), [5.5](#), and [6.12](#), one resistor at a time shall be shorted; and

d) For the test described in Clauses [5.11](#) and [6.13](#), as applicable, the lead of the resistor connected to the accessible part shall be disconnected.

4.3 Mechanical assembly

4.3.1 General

4.3.1.1 An appliance shall be so assembled that the vibration of normal operation will not result in a risk of electric shock, fire, or injury to persons.

4.3.1.2 Components such as switches, lampholders, receptacles and plug connectors provided as parts of equipment shall be fastened securely and rigidly, and shall be restricted from turning by means other than friction between surfaces. Lock washers, properly applied, may be used as a means to restrict the turning of stem-mounted controls, except those that operate with a rotary motion.

4.3.1.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, if such motion can result in a reduction of spacings below the minimum specified values. Friction between surfaces to restrict shifting or turning of live parts shall not be used, but a lock washer, properly applied, may be used.

4.3.1.4 Fluid-handling tubing shall be mechanically secured at connections if there is a risk of fire or electric shock should the tubing become disconnected (see Clause [5.12.8.1.1](#) (a) and (b)). Tubing subject to a pressure greater than 0.7 kg/cm² (10 psi) shall also comply with the tubing pressure test described in Clause [5.12.8.4](#).

Exception: Fluid-handling tubing subject to a pressure of 10 psi or less is not required to be mechanically secured if the tubing complies with the tubing pressure test (see Clause [5.12.8.4](#)).

4.3.1.5 Except as noted in Clause [4.3.1.6](#), an appliance shall be completely assembled before being shipped from the factory.

4.3.1.6 An appliance may be shipped from the factory partially disassembled to facilitate packaging if:

a) All parts for assembly that are necessary for the operation of the appliance are provided in one package; a package may consist of several cartons provided as a unit;

b) Proper assembly can be readily accomplished without introducing a risk of fire, electric shock, or injury to persons;

c) Clear and detailed assembly instructions are provided;

d) Internal electrical connections that must be made in the field are made by plug and receptacle connections only and do not require rearrangement of components or wiring. Internal connections that must be made in the field in an appliance intended for permanent connection to the power supply shall be made with means that comply with requirements in Clause [4.5.5](#) or by plug and receptacle connection; and

e) The appliance is marked in accordance with Clause [11.4.25](#), if a required guard is shipped from the factory detached.

4.3.2 Equipment intended for recreational vehicle or marine vessel installation

4.3.2.1 Vacuum cleaners intended for installation in marine vessels or recreational vehicles (R/Vs) shall be:

- a) Marked in accordance with Clauses [11.4.33](#) – [11.4.35](#); and
- b) Provided with installation instructions in accordance with Clauses [12.5.20](#) and [12.5.21](#).

4.3.2.2 For equipment intended for R/V or marine vessel installation, provisions such as mounting holes, clamps, lugs, or equivalent means shall be provided for securement of the equipment to the vehicle or vessel.

4.4 Corrosion protection

4.4.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the corrosion of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: In certain instances in which the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast-iron parts within an enclosure will in some cases not be required to be protected against corrosion.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, or the like need not be protected against corrosion.

4.4.2 If deterioration or breakage of a liquid container provided as a part of an appliance would result in a risk of fire, electric shock, or injury to persons, the container shall be of a material that is resistant to corrosion by the liquid intended to be contained.

4.4.3 In a vacuum cleaner with a steam-cleaning attachment, the metal sheath employed to enclose the heating element of an immersion-type water heater shall be protected against corrosion by enameling, galvanizing, plating, or other means, if the deterioration of such unprotected parts would be likely to result in risk of fire or electric shock; see Clause [4.18](#).

4.4.4 A vacuum cleaner with a steam-cleaning attachment that is provided with a reservoir intended to hold a liquid shall have all live parts located or otherwise protected so that they will not be subject to wetting if the reservoir were to leak. Compliance shall be determined by the tests in Clause [5.12.8](#).

4.4.5 For vacuum cleaners intended for marine vessel installation, all iron or steel parts of equipment, including bolts, nuts, screws, washers, and the like that are relied upon for compliance with the requirements in this standard, shall be provided with a corrosion-resistant finish by:

- a) A coating of chromium, nickel, silver, or zinc applied by electroplating;
- b) Sheradizing;
- c) Hot-dip galvanizing;
- d) Enameling, if the surface has been treated by bonderizing or the equivalent and by the application of zinc chromate primer prior to enameling; or
- e) Other types of paint or coatings that provide equivalent resistance to corrosion as determined in the Salt-Spray Corrosion Test, Clause [5.19.8](#).

4.4.6 With reference to Clause [4.4.5](#), the following materials are known to be corrosion resistant and need not be subjected to the Salt-Spray Corrosion Test:

- a) Silver;
- b) Copper;
- c) Brass;
- d) Bronze;
- e) Copper-nickel;
- f) Aluminum alloys with a copper content of 0.4% or less;
- g) Wood; and
- h) Polymeric material.

4.5 Supply connections

4.5.1 Cord-connected equipment

4.5.1.1 An appliance intended to be connected to the power supply circuit by means of a flexible cord shall be provided with a length of flexible cord and an attachment plug for connection to the supply circuit.

4.5.1.2 A cord set or power supply cord shall comply with C22.2 No. 21 and UL 817. Flexible cords and cables shall comply with C22.2 No. 49 and UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a cord set or power supply cord complying with C22.2 No. 21 and UL 817.

4.5.1.3 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs shall comply with C22.2 No. 42 and UL 498. See Clause [4.5.1.4](#).

Exception: Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of C22.2 No. 21 and UL 817, and need not comply with C22.2 No. 42 and UL 498.

4.5.1.4 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that can 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.

4.5.1.5 A stationary appliance may be provided with a length of flexible cord and an attachment plug for supply connection, if the use of the cord and attachment plug is intended to facilitate frequent service or maintenance; see Clause [4.5.1.17](#). The investigation of such a feature shall include consideration of the utility of the appliance and the necessity of having it readily detachable from its source of supply by means of the plug. A stationary appliance provided with a cord and attachment plug, and intended for outdoor use, shall be provided with the marking and instruction specified in Clauses [11.4.31](#) and [12.3.1\(g\)](#), respectively.

4.5.1.6 Supply cords and cord sets shall:

- a) Have a voltage rating not less than the rated voltage of the appliance;

- b) Have an ampacity not less than the current rating of the appliance; and
- c) Employ flexible cords as specified in [Table 2](#) or a type at least as serviceable.

Exception: For appliances provided with a general-use receptacle or receptacles, the requirements in Clause [4.14](#) are applicable; see Clauses [4.14.4](#) and [4.14.5](#) for the supply cord and cord set requirements for portable, shop-type vacuum cleaners provided with general-use receptacles.

4.5.1.7 The voltage rating of the attachment plug shall correspond to the voltage rating of the product and the ampere rating of the attachment plug based on its configuration (per ANSI/NEMA WD6), shall not be less than 125% of the ampere rating of the product. When the product has provision to be field adapted for use with two or more different supply voltages, the attachment plug on the power supply cord provided with the product shall be rated for the supply voltage selected at the factory. See Clause [11.3.2](#).

Exception No. 1: A stationary product marked in accordance with Clause [11.3.6](#) shall employ an attachment plug cap rated no less than the current rating of the appliance or the input current under normal load conditions as specified in Clause [5.2](#), whichever is greater.

Exception No. 2: A commercial vacuum cleaner marked in accordance with Clause [11.3.7](#), rated 120 V, 60 Hz shall employ an attachment plug cap rated not less than the current rating of the appliance.

Exception No. 3: A cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle or receptacles shall have an attachment plug rated not less than the current rating of the appliance. See Clause [4.14](#).

4.5.1.8 The attachment plug on an appliance intended to be connected to a nominal 120-V circuit, and employing devices required to be connected to a specific supply conductor as specified in Clauses [4.10.1.5](#), [4.13.3](#), and [4.14.15](#) shall be a polarized type. The connections to the attachment plug shall be in accordance with [Figure 5](#) and [Table 3](#). See also polarization instructions, Clause [12.4](#).

4.5.1.9 An appliance that is required to employ a polarized attachment plug as specified in Clause [4.5.1.8](#), and that is provided with a detachable cord set shall also employ an appliance connector of the polarized type.

4.5.1.10 The power-supply cord of a portable appliance shall exit from the body of the attachment plug in a direction parallel to the major dimension of the blades and at a point opposite a point on the face of the plug geometrically centered between the blades. An angled attachment plug shall not be provided with a portable appliance.

Exception: For a utility vacuum cleaner, an angled attachment plug with an integral ALCI or GFCI device may be provided.

4.5.1.11 The flexible cord may be attached permanently to an appliance or may be in the form of a separable cord set with means for connection to the appliance.

4.5.1.12 A household appliance intended for use with a detachable cord set shall not be provided with pin terminals that will accommodate a standard flatiron or an appliance plug.

4.5.1.13 For a commercial vacuum cleaner, a cord set (detachable power supply cord) with an IEC 60320 configuration appliance coupler exceeding 60°C (140°F) during the Temperature Test (see Clause [5.8](#)) shall be of the special use type. See Clauses [4.1](#), [4.5.1.14](#), [11.4.23](#), [11.4.22](#), and [12.2.10](#).

4.5.1.14 With reference to Clause [4.5.1.13](#), the appliance coupler temperature shall not exceed 70°C (158°F) and the rating of the coupler insulating material shall be at least 5°C (9°F) greater than the maximum measured temperature on the material.

4.5.1.15 Other than as noted in Clauses [4.5.1.18](#) and [4.5.1.19](#), the length of an attached flexible power supply cord for a vacuum cleaner or blower cleaner shall not be less than 1.82 m (6 ft) from the face of the attachment plug cap to the point at which the cord enters the appliance.

Exception: For a central vacuum cleaner, the length of the flexible power supply cord shall not be less than 0.9 m (3 ft). For required installation instructions see Clause [12.5.9](#).

4.5.1.16 A household-use floor finishing machine shall be provided with either a cord set (detachable power supply cord) or a power supply cord (nondetachable) not less than 4.57-m (15-ft) long, including fittings.

4.5.1.17 The length of a cord set, including fittings, shall not be less than 1.82 m (6 ft) except as specified in Clause [4.5.1.19](#).

4.5.1.18 A portable commercial appliance, portable outdoor use appliance or portable hand-supported blower cleaner may be provided with a power supply cord. If provided, this cord shall not be longer than 457 mm (18 in) of permanently attached flexible power-supply cord, as measured from the face of the attachment plug to the point at which the cord is last attached to the product, or with a connector base (motor-attachment plug) if:

- a) The appliance is marked in accordance with Clause [11.3.14](#) or provided with instructions in accordance with Clause [12.5.3](#); or
- b) The manufacturer furnishes a detachable cord set, 1.82 m (6 ft) or more in length, with the appliance.

4.5.1.19 The length of the power-supply cord or cord set on a wet pick-up appliance that is supported by the body of a person but not solely handheld shall be not less than 6.1 m (20 ft).

4.5.1.20 The means for connection (such as the attachment plug cap or connector base) of a wet pick-up appliance intended for use with a detachable cord set in accordance with Clause [4.5.1.11](#) or [4.5.1.18](#) shall be of the locking type.

4.5.1.21 With reference to Clause [4.5.1.20](#), the length of the attachment cord shall be such that the connection between the equipment attachment cord and the detachable cord set prevents the connection from being on the wet surface during intended use of the appliance.

4.5.1.22 An accessory, such as a detachable, electric power-driven brush, shall not be provided with a general purpose attachment plug.

Exception No. 1: An accessory intended for use with a central vacuum cleaning system may be provided with a general purpose attachment plug.

Exception No. 2: An accessory intended for use with an extraction-type carpet cleaning system intended for commercial use may be provided with a general purpose attachment plug.

4.5.1.23 A motorized nozzle intended to be connected to an appliance that is intended for wet pick-up shall be provided with:

- a) An attached flexible power-supply cord of such length as to plug directly into the appliance without the use of an intermediate connection such as a detachable cord set; or
- b) A cord-and-hose assembly that has been investigated and found to be acceptable for the application without creating a risk of fire, electric shock, or injury to persons when exposed to moisture.

4.5.1.24 An appliance incorporating a special-use connector and plug as a disconnecting means, such as a special use cord connector in the supply cord of a vacuum cleaner between the handle and the motor, shall have no exposed live parts under any normal condition as determined by the requirements in accessibility of live parts, Clause [4.2.5](#).

4.5.1.25 A 3- to 2-wire grounding type adaptor shall not be provided with an appliance.

4.5.1.26 A component cord reel (or cord winder) shall comply with the applicable construction and performance requirements of this standard. A cord reel that complies with C22.2 No. 21 and UL 355 is considered to fulfill these requirements only if it additionally complies with the applicable cord reel tests described in Clauses [5.8.4](#), [5.12.3](#), and [5.16](#) of this standard.

4.5.2 Pin terminals

4.5.2.1 An appliance provided with pin terminals shall have no live parts exposed to unintentional contact either during or after placement of a plug that is intended for the purpose on the pins in the normal manner.

4.5.2.2 A pin guard shall be provided that will restrict contact with any current-carrying pin by:

- a) A straight edge placed in any position across and in contact with edges of the plug opening without the plug in place to reduce the likelihood of mechanical damage to the pins; and
- b) The probe illustrated in [Figure 2](#) while the probe is inserted through any opening with the appliance in any position, with the plug aligned with the pins and the face of the plug in the plane perpendicular to the axis and tangent to the end of the farthest projecting current-carrying pin.

4.5.2.3 A fabricated pin terminal assembly shall comply with C22.2 No. 42 and UL 498.

Exception: A fabricated pin terminal assembly that complies with Clause [4.6](#) (current-carrying parts), Clause [4.8](#) (electrical insulation), and Clause [4.15](#) (spacings) of this standard is considered to meet this requirement.

4.5.3 Strain relief

4.5.3.1 Supply cords shall be provided with strain relief that reduces the likelihood of mechanical stress on the external portion of the cord from being transmitted to internal wiring, splices and terminals. The strain relief means shall comply with the test requirements specified in Clause [5.14](#).

4.5.3.2 Unless known to be acceptable for the purpose, a clamp of any material – metal or otherwise – shall not be used on a Type SVT cord or on cords of similar or lighter construction. For harder usage types of thermoplastic-insulated cord, clamps may be employed. In such cases, auxiliary insulation is not required unless it is determined that the cord grip may damage the insulation of the cord.

Exception: A clamp may be used on Type SVT (or similar) cord protected by varnished cloth tubing, phenolic, vulcanized fiber, or the equivalent under the cord grip, subject to the investigation described in Clause [5.14.3](#). Thermoplastic tubing is not acceptable over thermoplastic cords.

4.5.3.3 If a knot in a flexible cord serves as strain relief, a surface that the knot may contact shall be free from projections, sharp edges, burrs, fins, and the like that can cause abrasion of the insulation on the conductors.

4.5.3.4 It shall not be possible for flexible cords to be pushed into the appliance through the cord-entry holes, if such displacement

- a) Can subject the cords to mechanical injury or to exposure to a temperature higher than that for which the cord is intended; or
- b) Is liable to reduce spacings (such as from uninsulated live parts to a metal strain relief clamp) below the specified minimum values.

4.5.3.5 The flexible cord shall be restrained from any rotation that could cause movement of the internal wiring at splices and terminals.

4.5.4 Bushings

4.5.4.1 Holes in sheet-metal walls through which insulated conductors pass shall be provided with smoothly rounded bushings or shall have smooth, well-rounded surfaces upon which such conductors may bear.

4.5.4.2 Insulating bushings that comply with Clause [4.1.1](#) of this end product standard or 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 parts are suitable.

4.5.5 Permanently connected equipment

4.5.5.1 General

4.5.5.1.1 An appliance intended to be fastened or secured in position shall be provided with field-wiring terminals or leads for the connection of power-supply conductors, and shall have means for connection of a permanent wiring system.

4.5.5.1.2 Where openings for conduit are provided in sheet metal enclosures, the metal thickness shall be not less than 0.81-mm (0.032-in) thick if of sheet steel or 1.09-mm (0.043-in) thick if of nonferrous metal.

4.5.5.1.3 Terminal boxes or wiring compartments in which supply connections are made shall be located so that the connections will be accessible for inspection when the vacuum cleaner is installed as intended.

4.5.5.1.4 The compartment mentioned in Clause [4.5.5.1.3](#) shall be located so that, during conduit connections, internal wiring and electrical components will not be exposed to mechanical damage or strain.

4.5.5.1.5 A terminal compartment intended for connection of a supply raceway shall be attached to the appliance so as to be prevented from turning.

4.5.5.1.6 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with C22.2 No. 158 and UL 486E.

4.5.5.1.7 Terminal blocks shall comply with C22.2 No. 158 and UL 1059, and if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with C22.2 No. 158 and UL 1059 if the part complies with the requirements of Clause 4.5.5.2 (wiring terminals and leads), Clause 4.6 (current-carrying parts), Clause 4.8 (electrical insulation), and Clause 4.15 (spacings) of this end product standard. This exception does not apply to protective conductor terminal blocks.

4.5.5.1.8 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in C22.1, Wiring Methods, and ANSI/NFPA 70, Wiring Methods and Materials, that comply with the relevant CSA and UL standards, and Clause 4.1.1, are considered to fulfill the requirements of this Standard. Examples of relevant standards are C22.2 No. 18.1 and UL 514A, C22.2 No. 18.2 and UL 514C, C22.2 No. 18.3 and UL 514B, C22.2 No. 42.1 and UL 514D.

4.5.5.1.9 For equipment for installation in marine vessels, supply leads provided for connection to the branch circuit shall utilize only stranded copper conductors employing insulation:

- a) Of the flame retardant and moisture resistant type as specified in Article 310 of the National Electrical Code, ANSI/NFPA 70;
- b) That has been investigated for marine use; or
- c) That complies with the requirements for mechanical water absorption and the applicable flame tests requirements in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83/CSA C22.2 No. 75. The conductors shall be at least 16 AWG (1.3 mm²), if separate, or 18 AWG (0.82 mm²) if in a multiconductor sheath.

4.5.5.2 Wiring terminals and leads

4.5.5.2.1 A permanently connected appliance shall be provided with wiring terminals for the connection of conductors having an ampacity rated for the appliance; or the appliance shall be provided with leads for such connection.

4.5.5.2.2 An appliance required to be grounded and equipped with terminals or leads for field connections of power-supply conductors shall be provided with a terminal or lead for connection of an equipment-grounding conductor.

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

4.5.5.2.4 A terminal solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size necessary for the particular application. Solder alone shall not be used for connecting an equipment-grounding conductor.

4.5.5.2.5 A wiring terminal shall be provided with a soldering lug or with a pressure wire connector securely fastened in place – for example, firmly bolted or held by a screw.

Exception: A wire-binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in place.

4.5.5.2.6 A wiring terminal shall be prevented from turning.

4.5.5.2.7 The free length of a lead inside an outlet box or wiring compartment shall not be less than 152 mm (6 in) if the lead is intended for field connection to an external circuit.

Exception: The lead may be less than 152-mm (6-in) long if it is evident that the use of a longer lead might result in a risk of fire or electric shock.

4.5.5.2.8 A lead to be connected to a power-supply conductor in the field shall not be smaller than 18 AWG (0.82 mm²) and the insulation shall be thermoplastic with a wall thickness of at least 0.8 mm (1/32 in) or the equivalent.

4.5.5.3 Wire-binding screws

4.5.5.3.1 The size of a screw shall be not less than:

- a) No. 10 if for use with conductors larger than 14 AWG (2.1 mm²);
- b) No. 8 if for use with 14 AWG (2.1 mm²) conductors; or
- c) No. 6 if for use with conductors smaller than 14 AWG (2.1 mm²).

4.5.5.3.2 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size indicated in Clause [4.5.5.3.1](#) under the head of the screw or washer.

4.5.5.3.3 Wire-binding screws shall thread into metal.

4.5.5.4 Terminal plates and threading

4.5.5.4.1 Terminal plates through which wire binding screws are threaded shall have a thickness at least equal to twice the pitch of the thread of the screw but not less than 0.78 mm (0.030 in), and shall have at least two complete clean-cut full threads.

4.5.5.4.2 Screws engaging threaded holes in plates shall have not fewer than two full threads engaging under any reasonably foreseeable condition of service.

4.5.5.5 Identification of terminals and leads

4.5.5.5.1 A permanently connected appliance rated 125 or 125/250 V – 3-wire – or less and employing a lampholder of the Edison-screw-shell type, or a single-pole switch or overcurrent-protective device other than an 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 the one that is electrically connected to a screw shell of a lampholder and to which no switch or overcurrent protective device of the single-pole type other than an automatic control without a marked OFF position is connected.

4.5.5.5.2 A terminal intended for the connection of a grounded power supply conductor shall be of, or plated with, metal that is 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. A lead intended for connection 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.

4.5.5.5.3 The surface of an insulated lead intended solely for the 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.

4.5.5.5.4 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G", "GR", "Ground", or the like, or by a marking on a wiring diagram provided on the appliance. The wire-binding screw or

pressure wire connector shall be located so that it is unlikely to be removed during normal servicing of the appliance.

4.6 Current-carrying parts

4.6.1 A current-carrying part shall be of silver, copper, a copper alloy, stainless steel or other similar metal acceptable for the application.

4.6.2 Ordinary iron or steel shall not be used as a current-carrying part.

Exception: Ordinary iron or steel provided with a corrosion-resistant coating may be used for a current-carrying part if acceptable in accordance with Clause [4.1](#).

4.7 Internal wiring and external interconnections

4.7.1 Mechanical protection – Internal wiring

4.7.1.1 Internal wiring shall consist of conductors with a type of insulation rated for the particular application, when considered with respect to:

- a) Temperature and voltage to which the wiring will be subjected;
- b) Exposure to oil or grease; and
- c) Other conditions of service to which it is liable to be subjected.

4.7.1.2 Internal wiring composed of insulated conductors shall comply with C22.2 No. 127 or C22.2 No. 210 and UL 758.

Exception No. 1: Insulated conductors need not comply with the above reference standards if they comply with:

- a) C22.2 No. 38 and UL 44;
- b) C22.2 No. 75 and UL 83;
- c) C22.2 No. 49 and UL 66; or
- d) The appropriate CSA and UL standard(s) for other insulated conductor types specified in C22.1, Wiring Methods, and ANSI/NFPA 70, Wiring Methods and Materials.

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in an extra-low-voltage circuit not involving the risk of fire or personal injury need not comply with C22.2 No. 127 or C22.2 No. 210 and UL 758.

4.7.1.3 For the purpose of these requirements, internal wiring of an appliance shall be considered to be all the interconnecting wiring beyond the point where the power-supply cord of a cord-connected appliance enters the enclosure, or beyond the wiring terminals or leads for power supply connection of a fixed appliance, even though some of the wiring may be flexible cord.

4.7.1.4 With reference to exposure of insulated wiring through an opening in the enclosure of an appliance, the protection of such wiring required by Clause [4.7.1.1](#) shall be considered to exist if, when determined as though it were film-coated wire, the wiring would comply with accessibility of live parts, Clause [4.2.5](#). Internal wiring not so protected shall be secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

4.7.1.5 If the wiring of an appliance is located so that it may be subjected to mechanical damage, it shall be in armored cable, rigid metal conduit, electrical metallic tubing, metal raceway, or otherwise protected.

4.7.1.6 Wires within an enclosure, compartment, raceway, or the like shall be disposed or protected so that no damage to insulation of a conductor can result from contact with any rough, sharp, or moving parts.

4.7.1.7 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of the appliance.

4.7.2 Polarization of connectors – Internal wiring

4.7.2.1 If a device required to be connected to a specific supply conductor (see Clauses [4.10.1.5](#), [4.13.3](#), and [4.14.15](#)) is employed in an externally interconnected part, such as a motorized nozzle, the connections shall employ terminal fittings that can only mate such that the required connection to the proper supply conductor is maintained.

4.7.3 Splices and connections – Internal wiring

4.7.3.1 Splices and connections shall be mechanically secure and shall provide adequate and reliable electrical contact. Soldered connections shall be made mechanically secure before being soldered, if breaking or loosening of the connections can result in a risk of fire, electric shock, or injury to persons. Splices shall be provided with insulation equivalent to that of the wires involved if permanency of spacing between splices and other metal parts will in some cases not be maintained.

4.7.3.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG (0.34 – 5.3 mm²) copper conductors, having nominal widths of 2.8, 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 C22.2 No. 153 and UL 310.

Exception No. 1: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, and temperature rise, and all tests shall be conducted in accordance with C22.2 No. 153 and UL 310.

Exception No. 2: A connector that complies with C22.2 No. 153 and UL 310 may be used with an appropriately sized tab that complies with Annex B. The connector is the part of a quick-connect terminal that is pushed onto the male tab, and the tab is the part that receives the female connector.

Exception No. 3: For portable attended appliances, for connections where the breaking of the connection would not reduce the required electrical spacings (clearance and creepage), the connection shall comply with the following pull test and the temperature test requirements of Clause [5.8](#), where the temperature of the internal wiring is recorded at the point where it is terminated at the connector (see [Table 9](#), items 11 and 12, and note (c)). Connectors that terminate a wire shall withstand a pull of 5 N (1.1 lbf) applied for 10 s through the wire in the opposite direction from the force used to apply the connector. Neither the connector nor the wire shall become disconnected. In the case where the direction of the application is not in line with the exit direction of the wire, then the force shall be applied in both directions, one at a time.

4.7.3.3 Wire connectors shall comply with C22.2 No. 65 and UL 486A-486B.

4.7.3.4 Splicing wire connectors shall comply with C22.2 No. 188 and UL 486C.

4.7.3.5 In an appliance in which excessive vibration is likely to occur, the requirement in Clause [4.7.3.1](#) will necessitate the use of lock-washers or other means to prevent wire-binding screws and nuts from becoming loosened.

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

4.7.3.7 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill Clause [4.7.3.6](#) or a performance requirement of this standard. In such cases:

- a) Insulating tape shall comply with C22.2 No. 197 and UL 510;
- b) Sleeving shall comply with C22.2 No. 198.3 and UL 1441;
- c) Tubing shall comply with C22.2 No. 198.1 and UL 224.

4.7.3.8 Where stranded internal wiring is connected to a wire-binding screw, loose strands of wire shall be positively prevented from contacting other uninsulated live parts that are not always of the same polarity as the wire and from contacting non-current carrying metal parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other reliable means.

4.7.3.9 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method acceptable for the combination of metals involved at the point of connection.

4.7.3.10 With reference to Clause [4.7.3.9](#), if a wire-binding screw construction or a pressure wire connector is used as a terminating device, it shall be rated for use with aluminum under the conditions involved, for example, temperature, heat-cycling, and vibration.

4.7.3.11 Wire positioning devices shall comply with Clause [4.8](#) (electrical insulation). A device that complies with C22.2 No. 18.5 and UL 1565 is considered to fulfill this requirement.

4.7.4 Separation of circuits – Internal wiring

4.7.4.1 Conductors of circuits operating at different potentials shall be reliably separated from each other unless they are each provided with insulation rated for the highest potential involved.

4.7.4.2 An insulated conductor shall be reliably retained so that it cannot contact an uninsulated live part of a circuit operating at a different potential.

4.7.4.3 In a compartment that is intended for the field installation of conductors, and that contains provision for connection of extra-low voltage circuit conductors, and Class 1, power, or lighting circuit conductors, a barrier shall be provided to separate the conductors of the different circuits, or the arrangement of the compartment shall be such that a minimum spacing of 6.4 mm (1/4 in) can be maintained between the conductors of the different circuits including the conductors to be field installed.

4.7.5 External interconnections

4.7.5.1 The wiring and connections between electrical parts of an appliance shall be protected or enclosed. A length of flexible cord may be employed for external interconnections if flexibility is essential.

4.7.5.2 Any exposed flexible cord shall be of a type at least as serviceable as the power supply cord on the appliance unless located or protected so as to reduce the likelihood of mechanical damage.

4.7.5.3 Flexible cords shall comply with C22.2 No. 49 and UL 62. Flexible cord and cables are considered to fulfill this requirement when pre-assembled in a cord set or power supply cord complying with C22.2 No. 21 and UL 817.

4.7.5.4 A flexible cord used for external interconnection shall be provided with strain relief in accordance with Clause [4.5.3](#) unless the construction is such that the cord will be protected from stress or motion.

Exception: An external interconnecting cord located in a part of the enclosure that is capable of being opened or removed by the user without using a tool, such as a dust bag compartment, shall employ a strain-relief means that complies with the strain relief test, Clause [5.14](#), when subjected to a force of 89 N (20 lb).

4.7.5.5 Wiring routed between the handle and the base of an upright-type vacuum cleaner, and wiring routed between the base of a motorized nozzle and the appliance, that can be subjected to flexing or movement during normal operation of the appliance shall comply with Clause [5.18](#).

4.7.5.6 Single and multipole connectors used between electrical equipment that are intended for connection and disconnection of electrical attachments by the user shall comply with C22.2 No. 182.3 and UL 1977.

4.7.5.7 An IEC 60320 configured appliance inlet shall not be used for accessories intended and rated for extra-low voltage.

4.8 Electrical insulation

4.8.1 Current-carrying parts shall be supported on heat-resistant and moisture absorption-resistant insulating materials such as porcelain or phenolic composition.

4.8.2 Polymeric material employed to support a live part, in direct contact with a live part, or within 0.8 mm (1/32 in) from a live part shall be rated for use at the operating temperature involved and shall have the following material properties, all determined in accordance with C22.2 No. 0.17 and UL 746A:

- a) Volume resistivity of at least $50 \times 10^6 \Omega\text{-cm}$;
- b) Comparative tracking index (CTI) of at least 100 V (PLC 4 – see note (a) of [Table 4](#)); and
- c) A high current arc ignition (HAI) and hot-wire ignition (HWI) as specified in [Table 4](#).

Exception No. 1: In lieu of volume resistivity, compliance with the end-product leakage-current requirements (Clause [5.3](#)) is acceptable. Leakage current measurement shall be taken from accessible surfaces of the polymeric material in question. If the polymeric part in question is not accessible, the leakage current shall be measured in accordance with Clauses [5.3.3](#) and [5.3.4](#).

Exception No. 2: A material with a HAI property less than that required in [Table 4](#) may be used when the spacing over the surface of the material is at least 12.7 mm (1/2 in) between:

- a) Live parts of opposite polarity;
- b) Live parts and grounded noncurrent-carrying metal; and
- c) Live parts and exposed noncurrent-carrying metal.

Exception No. 3: A material that does not comply with the requirements specified in [Table 4](#) for HAI shall be evaluated using the power (current, voltage, and power factor) of the circuit in the end product by conducting a short-circuit test in accordance with end-product arc resistance, Clause [5.25](#).

Exception No. 4: Materials that do not comply with the minimum HWI requirements specified in [Table 4](#) shall comply with:

- a) The Abnormal overload test, [Clause 5.26](#);*
- b) The Glow-wire end-product test, [Clause 5.27](#); or*
- c) The UL 746A glow-wire ignitability test as follows:*
 - 1) The material shall have a glow-wire flammability index (GWFI) rating of at least the required glow-wire temperature specified in [Table 13](#) of this end-product standard; or the material shall have a glow-wire ignition temperature (GWIT) rating of at least 25°C higher than the required glow-wire temperature specified in [Table 13](#) of this end-product standard; and*
 - 2) The GWFI or GWIT rating shall be in a thickness that is within ± 0.1 mm (± 0.004 in) of the relevant end-product part, or if the rating is for a range of thicknesses, the relevant end-product part shall have a thickness within that range.*

Exception No. 5: Foamed thermoplastic material employed for sound reduction that is in direct contact with an uninsulated live part or is within 0.8 mm (1/32 in) of an uninsulated live part shall be rated HF-1 in accordance with C22.2 No. 0.17 and UL 94, and is not required to be evaluated for CTI, HWI, and HAI.

4.8.3 Thermoplastic parts employed to support live parts shall be subjected to the mold stress-relief distortion test, [Clause 5.21.3](#). As a result of the test, required spacings shall be maintained and the live parts shall remain reliably secured in place.

4.8.4 Fiber shall not be used as the sole support for uninsulated current-carrying parts if shrinkage, moisture absorption, or warping can introduce current leakage or a risk of electric shock, fire, or injury to persons. Untreated fiber shall not be used in contact with live parts where moisture absorption can result in a leakage current greater than that specified in [Clauses 5.3](#) and [5.4](#).

4.8.5 Small molded parts such as brush caps shall be constructed so as to have adequate mechanical strength and rigidity to withstand the most severe stresses that they are liable to be subjected to in service. As an alternative, such parts may have additional mechanical protection. (See [Clause 5.19.4](#).)

4.9 Motors

4.9.1 General

4.9.1.1 Motors shall comply with the requirements in [Clauses 4.9.1.2 – 4.9.1.5](#), and shall be of a type suitable for the particular application. They shall be capable of carrying the normal load (see [Clause 5.2](#)) without exceeding the permissible temperatures when the appliance is tested in accordance with the temperature test, [Clause 5.8](#).

Exception: A motor provided with integral insulation (e.g. epoxy coating) in lieu of slot liners shall also comply with UL 1446, and the integral insulation requirements specified in [Clause 5.29](#).

4.9.1.2 Motors having a NEMA frame size shall comply with C22.2 No. 100 and UL 1004-1. This includes fractional HP motors rated up to 1 HP (typically NEMA frame sizes 42, 48, or 56), and integral HP motors rated 1 HP and greater (typically NEMA frame sizes 140 – 449T).

4.9.1.3 Motors not enclosed, or partially enclosed, by the end product enclosure shall comply with C22.2 No. 100 and UL 1004-1.

4.9.1.4 Motors completely enclosed within the end product enclosure shall comply with one of the following:

- a) C22.2 No. 100 and UL 1004-1;
- b) UL 1004-1 except as noted in [Table 26](#); or
- c) The motor shall comply with the following construction requirements and the applicable performance requirements (when tested in conjunction with the end product), of this end product standard:
 - 1) Protection against corrosion, Clause [4.4](#).
 - 2) Terminal compartment, Clause [4.5.5](#).
 - 3) Internal wiring, Clause [4.7](#).
 - 4) Electrical Insulation, Clause [4.8](#).
 - 5) Motors, Clause [4.9](#).
 - 6) Capacitors, Clause [4.12](#).
 - 7) Spacings, Clause [4.15](#).
 - 8) Grounding, Clause [4.16](#).

4.9.1.5 Motors located in an extra-low voltage circuit shall be evaluated for the risk of fire and personal injury in accordance with the applicable requirements of this end product standard.

4.9.1.6 A motor winding shall resist the absorption of moisture.

4.9.1.7 With reference to the requirement in Clause [4.9.1.6](#), film-coated wire is not required to be additionally treated to reduce the likelihood of absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated to reduce the likelihood of moisture absorption.

4.9.1.8 The component requirements for film-coated wire and Class 105 (A) insulation systems are not specified. Film-coated wire in intimate combination with one or more insulators, and incorporated in an insulation system rated higher than Class 105 (A), shall comply with UL 1446 or CSA C22.2 No. 100.

4.9.1.9 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 (221°F) minimum. Leads shall be rated 90°C (194°F) minimum. Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with UL 1446. Motors employing thermoplastic materials shall be subjected to the tests in thermoplastic motor insulation systems, Clause [5.24](#).

Exception No. 1: Other polymeric materials used in a Class 105 (A) insulation system shall comply with the requirements for thermal aging in Clause [5.24.4](#).

Exception No. 2: Slot liners of polyethylene terephthalate that are 0.18-mm (0.007-in) thick minimum are not required to be subjected to the tests in Clause [5.24](#).

4.9.1.10 All insulation systems employing integral ground insulation shall comply with the requirements specified in C22.2 No. 100 and UL 1446.

4.9.2 Brushes and brush holders in commutator motors

4.9.2.1 A brush cap shall be recessed, enclosed, or otherwise protected from mechanical damage that might occur during normal use of the appliance unless the part performs acceptably in the impact test described in Clause [5.19.4](#).

4.9.2.2 A brush cap that is accessible to the user without the removal of a guard or enclosure shall be provided with a positive means that will prevent its disengagement from the brush holder assembly. Screw threads only on the brush cap are not considered a positive means.

4.9.2.3 A brush holder assembly shall be so constructed that when a brush is no longer capable of performing its function, the brush, spring, and other parts of the assembly will be retained to the degree necessary to prevent accessible noncurrent-carrying metal parts from becoming energized and to prevent live parts from becoming accessible.

4.9.3 Overload protection

4.9.3.1 A motor shall be provided with overload protection when it is:

- a) Automatically or remotely controlled;
- b) Permanently connected and manually started;
- c) In an unattended appliance;
- d) In a cord-connected, portable, utility vacuum cleaner provided with a receptacle as specified in the Exception to Clause [4.14.1](#); or
- e) In a coin-operated appliance.

4.9.3.2 A product as mentioned in Clause [4.9.3.1](#) shall have motor-overload protection as specified below:

- a) Thermal protection complying with the applicable requirements in C22.2 No. 77 and UL 1004-3;

Exception No. 1: The locked-rotor temperature test on a manually reset device shall be continued for four operations (that is three resets, four trips) of the protective device.

Exception No. 2: A motor intended to move air only, by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor, is not required to have running-overload protection.

Exception No. 3: A shaded-pole motor with a 2:1 or smaller ratio between locked-rotor and no-load currents and a 1 A or smaller difference between no-load and locked-rotor current shall be considered to have acceptable overload protection if it is protected against locked-rotor conditions only.

Exception No. 4: For permanent connected appliances, the overcurrent protection of Clause [4.9.3.9](#) may be used in place of thermal motor protection.

- b) Impedance protection complying with the applicable requirements in C22.2 No. 77 and UL 1004-2, when the motor is tested as used in the product under stalled-rotor conditions; or

c) Electronic protection integral to the motor shall comply with Clause [4.11.4](#), or C22.2 No. 77 and UL 1004-7.

4.9.3.3 For a multispeed motor of any of the types mentioned in Clause [4.9.3.1](#) that employs a separate overload protective device to provide running-overload protection, the requirements in Clause [4.9.3.2](#) apply at all speeds at which the motor is intended to operate.

4.9.3.4 The motor of an appliance with load characteristics likely to result in an overload or stalled condition that will not be evident to the user shall incorporate thermal or overload protection in accordance with the requirements in Clause [4.9.3.2](#).

4.9.3.5 A thermal or overload protective device shall not open the circuit during the temperature test, Clause [5.8](#).

4.9.3.6 The functioning of a motor-protective device provided as part of an appliance, whether such device is required or not, shall not result in a risk of fire, electric shock, or injury to persons.

4.9.3.7 Fuses employed for motor-running overload protection shall be located in each ungrounded conductor.

4.9.3.8 Devices other than those that are inherent in a motor employed for motor-running overload protection shall be located in each ungrounded conductor.

4.9.3.9 A separate device incorporated in a permanently connected appliance in accordance with the requirements in Exception No. 4 to Clause [4.9.3.2](#) (a) shall be responsive to motor current and shall be rated or set in accordance with [Table 27](#) (column A). Each winding connection of a multispeed motor shall be considered separately.

Exception: If the rating of the device determined in accordance with [Table 27](#) (column A) does not correspond to a standard size or rating of fuses, nonadjustable circuit breakers, thermal cutouts, thermal relays, or heating elements of thermal-trip motor switches, or is not sufficient to start the motor or carry the load, a device of the next higher size, rating, or setting may be used, provided the trip current does not exceed the value specified in of [Table 27](#) (column B).

4.10 Switches, relays, and similar controls

4.10.1 General

4.10.1.1 Switches, relays, and similar controls shall be suitable for their particular application, and shall have current, voltage, and load ratings not less than those of the circuits controlled.

4.10.1.2 A switch or other control shall be guarded or located so that it is not likely to be damaged during use of the appliance. A through-cord switch shall not be employed unless:

- a) It cannot contact the floor during use of the appliance; or
- b) It has been investigated for such abuse as may occur during use.

4.10.1.3 A motor control switch shall be provided in a cord-connected appliance that employs a motor rated more than 1/3 hp (249 W output). For motors without a hp rating, 1/3 hp is considered a motor rated 480 VA. The switch shall be in a readily accessible location.

Exception: An extra-low voltage current-carrying hose contact that energizes a relay or triac which turns on the motor of the central vacuum complies with this requirement.

4.10.1.4 A switch, relay, or similar control that controls a motor shall be subjected to the test in Clause [5.15](#).

Exception: A switch is not required to be subjected to the Clause [5.15](#) test if it complies with the standards specified in Clause [4.10.2.1](#) and the following criteria:

- a) Is marked with a HP (horsepower) rating equal to or greater than the marked HP of the motor switched;*
- b) Is marked with a HP rating that yields a relevant full-load current equal to or greater than the full load current associated with the motor switched;*
- c) Is marked with a HP or LRA rating equal to or greater than the locked rotor current associated with the motor switched; or*
- d) Has a GP (general purpose/use) rating, and complies with the following:*
 - 1) The power factor of the motor is greater than 80% under maximum normal load and under stalled armature (or locked rotor) conditions; and*
 - 2) For switches rated 10 A or less, the motor's stalled armature (or locked rotor) current is less than 150% of the switch's current rating. For switches rated more than 10 A, the motor's stalled armature (or locked rotor) current is less than 125% of the switch's current rating.*

4.10.1.5 A switch or an overcurrent-protective device of the single pole type shall be electrically connected to the ungrounded conductor of the supply circuit.

Exception No. 1: An automatic control without a marked OFF position need not be connected to the ungrounded conductor.

Exception No. 2: For an appliance with a main ON-OFF switch any subsequent switch that does not control the entire appliance need not be connected to the ungrounded conductor.

4.10.1.6 A control shall comply with the requirements specified in Clause [4.11](#).

4.10.2 Ratings

4.10.2.1 Switches that comply with C22.2 No. 55 and UL 1054 shall be rated:

- a) For a voltage not less than the rated voltage of the appliance;
- b) For a current not less than the rated current of the appliance;
- c) For the type of load that is switched in the appliance;
- d) For ac if the appliance is rated for ac; or
- e) For dc if the appliance is rated for dc.

4.10.2.2 Switches that comply with C22.2 No. 61058-1 and UL 61058-1 shall be rated as specified in Clauses [4.10.2.2.1](#) – [4.10.2.2.3](#).

4.10.2.2.1 Power switches shall be rated as follows:

- a) For a voltage not less than the rated voltage of the appliance;

b) For a current not less than the rated current of the appliance;

c) For Continuous Duty;

d) With respect to load:

1) Switches for motor-operated appliances: for resistance and motor load in accordance with Clause 7.1.2.2 of C22.2 No. 61058-1 and UL 61058-1, or UL 6059, if the switch would encounter this load in normal use; or

2) Switches may be regarded as switches for a declared specific load in accordance with Clause 7.1.2.5 of C22.2 No. 61058-1 and UL 61058-1, or UL 6059 and may be classified based upon the load conditions encountered in the appliance under normal load; see Clause [5.2](#).

e) For ac if the appliance is rated for ac;

f) For dc if the appliance is rated for dc.

4.10.2.2.2 Ratings and load classifications for switches other than power switches shall be based on the conditions encountered in the appliance under normal load; see Clause [5.2](#).

4.10.2.2.3 Switches shall also be rated with respect to endurance as follows:

a) Power switches: 6000 cycles;

b) Power switches provided with series electronics shall be subject to an additional 1000 cycles of operation with the electronics bypassed;

c) Switches other than power switches, such as speed selector switches, that may be switched under electrical load: 1000 cycles;

d) The following non-power switches are not required to be rated for endurance:

1) Switches intended for operation without electrical load, and which can be operated only with the aid of a tool or are interlocked so that they cannot be operated under electrical load; or

2) Switches for 20 mA load as classified in Clause 7.1.2.6 of C22.2 No. 61058-1 and UL 61058-1.

4.10.2.3 Switches that do not comply with the standards specified in Clauses [4.10.2.1](#) or [4.10.2.2](#) shall be tested in accordance with Clauses [4.10.2.4](#) and [4.10.2.5](#).

4.10.2.4 Switch Endurance – three samples of the switch shall be subjected to the accelerated cycle endurance test of Clause 17.2.4.4 of C22.2 No. 61058-1 and UL 61058-1, but with the load conditions as specified in Clauses [4.10.2.4.1](#) or [4.10.2.4.2](#), and using the number of cycles as specified in Clause [4.10.2.2.3](#).

4.10.2.4.1 For switches tested with an external load, the load conditions are as follows:

a) Power switches are regarded as classified to Clause 7.1.2.2 of C22.2 No. 61058-1 and UL 61058-1. They are tested with 6 x I-M making current and a power factor 0.6 ± 0.05 , and with I-M breaking current and a power factor ≥ 0.9 , the I-M current being the current measured during normal load; see Clause [5.2](#).

b) Switches other than power switches, but which would encounter the same load conditions as power switches in normal use, shall be tested with the corresponding load conditions above.

4.10.2.4.2 For switches tested utilizing the motor load encountered in the appliance, the switch is tested at rated voltage for the required number of cycles. The cycles shall be conducted as quickly as possible but need not meet the requirements of Clause 17.2.3.4.1 of C22.2 No. 61058-1 and UL 61058-1. Each cycle shall consist of the following:

- a) With the appliance motor at rest, the switch is closed with the appliance under the normal load as defined in Clause [5.2](#);
- b) The switch is opened with the appliance loaded to normal load.

4.10.2.5 Switch overload or breaking capacity – the switch shall be tested in accordance with Clause [5.15](#).

4.10.3 Switches and controls for use in vacuum cleaners with a steam-cleaning attachment

4.10.3.1 In addition to complying with the applicable requirements in Clauses [4.10.1](#) and [4.10.2](#), a vacuum cleaner with a steam-cleaning attachment shall be provided with a manually actuated switch or control (deadman-type) for the release of steam. The switch or control actuator shall be biased to the off position and located or guarded to reduce the likelihood of unintentional operation.

4.10.3.2 A switch used in the operation of a vacuum cleaner with a steam-cleaning attachment shall be the indicating type.

4.10.3.3 A thermostat that complies with the construction requirements of the following UL and CSA standards is considered to comply with the construction requirements of this standard. See Clause [5.30](#) for the applicable performance requirements.

- a) C22.2 No. 24 and UL 873;
- b) C22.2 No. 24 and UL 353; or
- c) CAN/CSA-E60730-1 and UL 60730-1, and CAN/CSA-E60730-2-9 and UL 60730-2-9.

4.10.4 Flexible switch actuators

4.10.4.1 A switch or control that is actuated by a flexible thermoplastic material (such as used in a membrane-type switch) and that functions as a main ON-OFF switch shall comply with Clause [5.15.3](#), in addition to complying with the other applicable switch requirements in Clause [4.10](#).

4.10.4.2 With respect to Clause [4.10.4.1](#), a membrane-type switch is considered to be a momentary switching device in which at least one contact is on, or made of, a flexible substrate.

4.11 Controls – End product test parameters

4.11.1 General

4.11.1.1 Spacings of controls shall comply with the electrical spacing or clearances and clearance distance requirements of Clause [4.15](#).

4.11.1.2 Where reference is made to Type 2 controls and declared deviation and drift, this indicates the manufacturer's declaration of the control tolerance before and after certain conditioning tests.

4.11.1.3 For other than protective controls, if there is no increased risk of fire, electric shock, or personal injury hazard during normal and abnormal testing with the electronic control circuit rendered ineffective, compliance with the applicable requirements of this end product standard is required (compliance with the control standard requirements is not needed).

4.11.1.4 As an alternative to complying with the applicable requirements of CAN/CSA-E60730-1 and UL 60730-1, an electronic control that performs a safety-critical function shall comply with the requirements in Clause [4.11.4](#).

4.11.2 Auxiliary controls

4.11.2.1 Auxiliary controls shall not introduce a risk of electric shock, fire, or personal injury hazard.

4.11.2.2 Auxiliary controls shall comply with the requirements of this end product standard.

Exception: An auxiliary control that complies with a referenced component control standard is considered to fulfill this requirement.

4.11.3 Operating controls (regulating controls)

4.11.3.1 The following test parameters shall be among the items considered when determining the acceptability of an operating control investigated using CAN/CSA-E60730-1 and UL 60730-1:

- a) Control action Types 1 or 2;
- b) Unless otherwise specified in this standard, manual and automatic controls shall be tested for 6,000 cycles under maximum normal load conditions, and 50 cycles under overload conditions;
- c) For the applicable Overvoltage Category, see [Table 23](#);
- d) For the applicable Material Group, see [Table 24](#);
- e) For the applicable Pollution Degree, see [Table 25](#).

4.11.4 Electronic controls for safety-critical functions

4.11.4.1 An electronic control that performs a safety-critical function shall comply with the requirements in this section, unless the control when bypassed does not result in noncompliance with the standard. Examples of controls providing a safety-critical function are: a control used to sense abnormal temperatures of components within the appliance; an interlock function to de-energize a motor; temperature protection of the motor due to locked rotor, running overload, loss of phase; or other function intended to reduce the risk of electric shock, fire, or injury to persons as identified in this standard. A summary of these are listed in [Table 29](#). The general requirement is that these controls must demonstrate functional reliability commensurate with the risk that they guard against. This can be achieved through the specific requirements of either Clause [4.11.4.2](#) or [4.11.4.3](#) and the following environmental tests contained in CAN/CSA-E60730-1 and UL 60730-1 with the following parameters:

- a) Power supply voltage dips, variation and interruptions within a temperature range of 10°C (50°F) and the maximum ambient temperature determined by conducting the Temperature Test; see Clause [5.8](#);
- b) Surge immunity test – installation class 3 shall be used;
- c) Electrical fast transient/burst test, a test level 3 shall be used;
- d) Electrostatic Discharge Test;

e) Radio-frequency electromagnetic field immunity:

- 1) Immunity to conducted disturbances – When applicable, test level 3 shall be used; and
- 2) Immunity to radiated electromagnetic fields; field strength of 3 V/m shall be used;

f) Thermal Cycling test shall be conducted at ambient temperatures of 10.0 +2°C (50.0 +3.6°F) and the maximum ambient temperature determined by conducting the Temperature Test; see Clause [5.8](#). The test shall be conducted for 14 days; and

g) Overload shall be conducted based on the maximum declared ambient temperature (Tmax) or as determined by conducting the Temperature Test; see Clause [5.8](#).

4.11.4.2 The following shall be considered when judging the acceptability of an electronic protective control investigated using CAN/CSA-E60730-1 and UL 60730-1:

- a) Failure-Mode and Effect Analysis (FMEA) or equivalent Risk Analysis method;
- b) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class B in Annex H, Clause H.11.12.3 in CAN/CSA-E60730-1 and UL 60730-1.

4.11.4.3 The test parameters and conditions used in the investigation of the circuit covered by Clause [4.11.4.1](#) shall be as below:

a) The reliability of portions of the electronic circuit that are responsible for the safety-critical function are evaluated by the MTTF_d (Mean Time To Dangerous Failure) calculations required to meet the necessary Performance Level (PL) associated with the safety-critical function as described in ISO 13849-1; see Annex H. In cases of single channel designs, the required MTTF_d for each performance level is as follows:

PL = a: MTTF_d = 5 years;

PL = b: MTTF_d = 20 years;

PL = c: MTTF_d = 50 years.

b) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class B in accordance with CAN/CSA-E60730-1 and UL 60730-1, Annex H, Clause H.11.12.3.

4.11.4.4 Unless otherwise specified in this standard, controls with electromechanical or pressure activated actuation shall be evaluated for 100,000 cycles for Type 2 devices and 6,000 cycles for Type 1 devices with the current encountered in the application.

4.11.5 Controls using a temperature sensing device

4.11.5.1 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control, shall be tested using the following number of cycles when testing a sensing device in accordance with the endurance test:

- a) For a device employed as an operating device – 6000 cycles,
- b) For a device employed as a protective device – 100,000 cycles, and
- c) For a device employed as a combination operating and protective device – 100,000 cycles.

4.12 Capacitors

4.12.1 A capacitor provided as part of a capacitor/motor combination, and a capacitor connected across-the-line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container so that mechanical damage to the plates is unlikely to occur and so that there will be no emission of flame or molten material resulting from breakdown or malfunction of the capacitor. The container shall be of metal providing strength not less than that of uncoated steel having a thickness of 0.51 mm (0.020 in).

Exception: The container of a capacitor may be made of sheet metal having a lesser thickness or may be of material other than metal, if the capacitor is mounted in an enclosure that houses other parts of the appliance, and if such box, case, or the like is acceptable for the enclosure of current-carrying parts as specified in Clause [4.2.1](#).

4.12.2 In an appliance that is intended to be automatically or remotely controlled, if a capacitor that is not a part of a capacitor/motor combination or a capacitor-start motor is connected so that capacitor breakdown or malfunction would result in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the appliance.

4.12.3 If an appliance employs a combination consisting of a rectifier and an electrolytic capacitor, no risk of fire, electric shock, or injury to persons shall result if either the rectifier or the capacitor is short-circuited.

4.12.4 If an appliance is intended to be controlled by or operated in conjunction with a capacitor or a capacitor/transformer unit, such a capacitor or unit shall be supplied with the appliance. See Clause [11.3.4](#).

4.12.5 Under both normal and abnormal conditions of use, a capacitor employing a dielectric medium more combustible than askarel shall not result in risk of fire or electric shock, and shall be constructed to reduce the likelihood of expelling the dielectric medium.

4.12.6 A capacitor complying with the applicable requirements for protected oil-filled capacitors specified in C22.2 No. 190 and UL 810 shall be considered to be constructed to reduce the likelihood of expelling the dielectric medium.

4.12.7 For a capacitor employing a liquid dielectric medium more combustible than askarel and provided with an expansion mechanism to reduce the likelihood of expelling the dielectric medium, the spacing from a terminal of the capacitor, including an assembled wire connector, to:

- a) An electrically isolated part or a part constructed of a nonconductive material shall be at least 12.7 mm (1/2 in); or
- b) An uninsulated live part of opposite polarity or an uninsulated noncurrent-carrying metal part that is either accessible or grounded shall not be less than the sum of the appropriate value from [Table 5](#) and 12.7 mm (1/2 in).

4.12.8 Electromagnetic interference filters with integral enclosures that comply with C22.2 No. 8 and UL 1283 are considered to fulfill the requirements of Clause [4.12](#) (capacitors).

4.13 Lampholders

4.13.1 Lampholders for extra-low-voltage lamps (that is, lamps rated at 30 V or less) shall not be tapped across parts of motor windings if the motor rating is more than 150 V.

4.13.2 Lampholders and lamps shall be adequately secured and protected from mechanical injury.

4.13.3 An Edison-base lampholder shall be wired so that the screw-shell will be electrically connected to the grounded conductor of the power-supply circuit.

4.13.4 Lampholders and indicating lamps shall comply with C22.2 No. 43 and UL 496.

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

4.13.5 Light emitting diode (LED) light sources shall comply with C22.2 No. 12 and UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with an appropriate CSA and 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 C22.2 No. 12 and UL 8750, but shall comply with the applicable requirements of this end product standard.

4.14 Receptacles

4.14.1 A cord-connected, portable appliance shall not be provided with a general-use receptacle.

Exception: A cord-connected, portable, utility vacuum cleaner may be provided with a general-use receptacle or general-use receptacles, if it complies with Clauses [4.14.2](#) – [4.14.15](#), and it shall be marked with the cautionary markings specified in Clause [11.4.22](#), and be provided with the instruction specified in Clause [12.2.11](#).

4.14.2 A general-use receptacle shall be of the grounding type.

4.14.3 A cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle or receptacles shall have a current rating as required in [Table 28](#) and be provided with an attachment plug rated not less than the current rating of the appliance.

4.14.4 The power-supply cord of a cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle or receptacles shall be of the grounding type and shall employ one of the following flexible cord Types: SJ, SJE, SJO, SJT, SJTO, or equivalent. A cord marked with suffix "W" (such as, SJTW) is required when the appliance is intended for outdoor use. A cord set (detachable power-supply cord) shall not be used.

4.14.5 The minimum conductor size of the power-supply cord for a portable, utility vacuum cleaner shall be as indicated in [Table 28](#).

4.14.6 An overcurrent protection device (OCP) as required by [Table 28](#) or Clause [4.14.16](#) shall be suitably rated and comply with the following:

- a) The requirements in C22.2 No. 235 and UL 1077; or
- b) A fuse that complies with the requirements in C22.2 No. 248.14 and UL 248-14; or
- c) A circuit breaker that complies with the requirements in C22.2 No. 5 and UL 489.

4.14.7 The general-use receptacle(s) shall have a current rating of 15 or 20 A and a voltage rating of 125 or 250 V. The receptacles shall have a voltage and current rating equal to that of the attachment plug on the power-supply cord.

Exception: A 15-A general-use receptacle is not prohibited from being used with an appliance rated 20 A with a 20-A attachment plug.

4.14.8 When multiple general-use receptacles are provided, they shall all have the same current rating. These receptacles may be of the same or different slot configurations (locking and non-locking) or employing a spring-actuated latching mechanism for locking a mated attachment plug in place after the blades have been inserted into the female contacts.

4.14.9 The receptacles of an appliance shall comply with the applicable requirements in C22.2 No. 42 and UL 498. Each general-use receptacle provided in an appliance that is either equipped with temporary mounting means or intended for use in a fixed application, and having the configuration specified in Figure C1.5 of UL 1681, shall comply with the requirements of the Grounding Contact Test in C22.2 No. 42 and UL 498.

4.14.10 The face of a general-use receptacle shall:

- a) Be flush with or project beyond a nonconductive surrounding surface; or
- b) Project at least 0.38 mm (0.015 in) beyond a conductive surrounding surface.

4.14.11 Ground-fault circuit protection (Class A) shall be provided for general-use receptacles that are part of a fixed or stationary appliance intended to be used outdoors. The ground-fault circuit protection (Class A) shall comply with C22.2 No. 144.1 and UL 943.

4.14.12 An attachment-plug receptacle of an appliance intended for wet pick-up shall be located so that it is unlikely to be wetted.

4.14.13 Polymeric material that encloses unswitched receptacles associated circuitry that is always energized when the appliance is plugged in shall comply with Clause [4.2.1.5\(c\)](#).

4.14.14 The general-use receptacle(s) of an appliance shall function using one of the following methods:

- a) Always On (Unswitched) – a receptacle on the appliance is energized when the appliance is plugged into a receptacle;
- b) Switched – receptacles switched via one or more suitably rated switches provided the receptacle is marked as required in Clause [11.4.22\(b\)](#); or
- c) Auto – one or more receptacles are designed to turn on the vacuum cleaner when a receptacle load is sensed. The receptacle(s) shall be Always On (Unswitched).

Exception: The switches provided for receptacles may have other positions, provided that they are suitably marked and their function described in the instruction manual. The switch shall be marked to clearly indicate which receptacle(s) it controls and the receptacle(s) shall be marked as required in Clause [11.4.22\(c\)](#).

4.14.15 A general-use receptacle for use on a nominal 120 V circuit shall have the grounded supply conductor connected to the terminal that is substantially white in color or otherwise marked to indicate that it is intended for connection to the grounded supply conductor.

4.14.16 If a permanently connected appliance includes one or more attachment-plug receptacles intended for general use, and if the overcurrent protection of the branch circuit to which the appliance will properly be connected exceeds that acceptable for the receptacle or receptacles, each receptacle circuit shall have suitable overcurrent protection provided as a part of the appliance.

4.15 Spacings

4.15.1 General

4.15.1.1 Except as permitted in Clauses [4.15.1.5](#) and [4.15.1.6](#), spacings shall not be less than those specified in [Table 5](#) or [Table 6](#). If uninsulated live parts are not rigidly supported by means other than friction or if movable noncurrent-carrying metal parts are in proximity to uninsulated live parts, the construction shall be such that the minimum spacings specified will be maintained under all conditions.

4.15.1.2 Spacings at wiring terminals to which supply connections are made in the field shall comply with [Table 5](#):

- a) Between uninsulated live parts of opposite polarity;
- b) Between uninsulated live parts and noncurrent-carrying metal parts; and
- c) Between line voltage parts and extra low voltage parts.

4.15.1.3 At a terminal screw and stud to which connection may be made in the field by means of a wire connector, an eyelet, or the like, it is required that the spacings be not less than those specified in [Table 5](#) when such connector, eyelet, or the like is in such position that minimum spacings – between opposite polarity and to noncurrent-carrying metal – exist.

4.15.1.4 Spacings shall comply with [Table 6](#) at points other than as specified in Clause [4.15.1.2](#) or [4.15.1.3](#) that are:

- a) Between uninsulated live parts of opposite polarity;
- b) Between uninsulated live parts and noncurrent-carrying metal parts including the enclosure; and
- c) Between line voltage parts and extra low voltage parts.

Exception No. 1: In other than safety or protective control circuits, a spacing less than the minimum specified in [Table 6](#) is acceptable under the conditions described in the Limited Power Point Determination Test specified in UL 244A.

Exception No. 2: The spacings on printed wiring boards may be evaluated in accordance with Clause [4.15.3](#).

Exception No. 3: Spacings between traces on a printed wiring board need not comply with [Table 6](#) if the printed wiring board complies with the printed wiring board abnormal operation test in Clause [5.10.6](#). The requirements specified in Clause [5.10.6](#) do not substitute for the minimum required spacings between the printed wiring board foils and dead metal parts or the spacings between the primary and secondary foils of the printed wiring board as specified in [Table 6](#).

4.15.1.5 The spacings within motors, snap switches, lampholders, or other devices supplied as part of the equipment shall comply with the requirements of the standard for that component. See Clause [4.1](#).

Exception: The spacings within a motor complying with [Table 6](#) need not comply with the component spacings requirements in C22.2 No. 100.

4.15.1.6 An insulating barrier or liner may be used to obtain the required spacings if it is:

- a) Of adequate dielectric strength and resistance to moisture;
- b) Not adversely affected by arcing and suitable for the temperatures encountered;
- c) Of adequate mechanical strength and permanently retained in place by means other than adhesives, unless evaluated per Clause [4.2.4.1](#); and
- d) Not less than 0.8-mm (1/32-in) thick if vulcanized fiber, except that it may be not less than 0.4-mm (1/64-in) thick if used in conjunction with a through-air spacing not less than one-half of that required.

4.15.1.7 Spacings are not specified for the following types of circuits:

- a) An extra low voltage circuit – see Clause [3](#);
- b) Between traces on a printed wiring board in circuits that:
 - 1) Are located on a part of a printed wiring board provided with conformal coating that complies with Clause [4.1.2.4](#); or
 - 2) Are connected to the load side of a resistor such that a short circuit from that point to the other side of the supply does not result in the wattage rating of the resistor being exceeded.

4.15.1.8 All uninsulated live parts connected to different line- or extra low-voltage circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirements in Clause [4.15.1.2](#) and shall be judged on the basis of the highest voltage involved.

4.15.1.9 In applying [Table 6](#) to an appliance incorporating two or more motors of different sizes, the spacings in the appliance are judged on the basis of the size of the largest motor in the appliance.

4.15.1.10 In applying [Table 6](#) to a motor not rated in horsepower, use shall be made of the appropriate table of the Electrical Code (see Clause [1](#)) that gives the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating-current motor shall be used if the appliance is marked for use on alternating current only; otherwise, the table applying to direct-current motors shall be used.

4.15.2 Spacings to polymeric enclosures

4.15.2.1 The spacings between the polymeric enclosure and:

- a) A nonarcing uninsulated live part (a bus bar, a connecting strap, a terminal, or the like) shall be no less than 0.8 mm (1/32 in). If less than a 0.8 mm (1/32 in) spacing is provided, the enclosure material shall comply with the requirements for support of live parts described in Clause [4.8.2](#), unless an acceptable insulating barrier is employed; or
- b) An arcing part (at a commutator, unenclosed switch contacts, and the like) shall not be less than 12.7 mm (1/2 in) except as indicated in Clause [4.15.2.3](#).

4.15.2.2 The spacing mentioned in Clause [4.15.2.1\(b\)](#) shall be measured from the source of the arc – that is, from the interface of the brush and the commutator or from the interface of the switch contacts, and the like.

4.15.2.3 The spacing mentioned in Clause [4.15.2.1\(b\)](#) may be less than 12.7 mm (1/2 in) but not less than 0.8 mm (1/32 in) if the material has a minimum high-current arc ignition (HAI) as noted in [Table 4](#). If

the spacing is less than 0.8 mm (1/32 in), the material shall comply with all of the requirements for support of live parts described in Clause [4.8.2](#).

4.15.3 Spacings on printed wiring boards

4.15.3.1 As an alternative to the spacing requirements of [Table 6](#), the spacing requirements in C22.2 No. 0.2 and UL 840 may be used. The spacing requirements of C22.2 No. 0.2 and UL 840 shall not be used for field wiring terminals and spacings to a dead metal enclosure.

4.15.3.2 The following end use factors from this standard shall be applied:

- a) For the applicable Overvoltage Categories, see [Table 23](#);
- b) For the applicable Material Group, see [Table 24](#);
- c) For the applicable Pollution Degrees, see [Table 25](#).

4.15.3.3 In order to apply Clearance B (controlled overvoltage) clearances, control of overvoltage shall be achieved by providing an overvoltage device or system as an integral part of the product. This voltage limiting device or system shall comply with C22.2 No. 8 and UL 1283, or UL 1449.

4.15.3.4 All printed wiring boards are identified as having a minimum comparative tracking index (CTI) of 100 without further investigation, for evaluation to C22.2 No. 0.2 and UL 840.

4.16 Grounding and bonding

4.16.1 An appliance of one or more of the following types shall have provision for grounding:

- a) An appliance intended to be used on a circuit operating at more than 150 V to ground – see Clause [4.16.2](#);
- b) A central vacuum cleaner;
- c) A commercial vacuum cleaner or blower cleaner;
- d) A household utility vacuum cleaner or blower cleaner;
- e) A wet pick-up vacuum cleaner, including a household use vacuum cleaner with steam-cleaning attachment;
- f) A household use floor finishing machine;
- g) A cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle as specified in the Exception to Clause [4.14.1](#);
- h) An electrified wall valve assembly (see Clause [8.2.7](#)); or
- i) An appliance intended to be used outdoors.

Exception: A cord-connected appliance, other than as described in (g), provided with a system of double insulation as specified in double insulation, Clause [6](#), is not required to have provision for grounding.

4.16.2 With reference to Clause [4.16.1](#), a 2-wire appliance intended to operate at a nominal potential of 240 V and any other potential greater than 150 V, shall be provided with means for grounding in accordance with Clauses [4.16.4](#) and [4.16.5](#) unless the marked rating on the appliance is 120/240 V or the

appliance is otherwise marked to indicate that it is to be connected to a circuit operating at 150 V or less to ground.

4.16.3 If a grounding means is provided, whether required or not, it shall be in accordance with Clause [4.16.4](#) and if the appliance is cord connected it shall comply with the requirements in Clause [4.16.5](#). All exposed noncurrent-carrying metal parts and all noncurrent-carrying metal parts within the enclosure that are exposed to contact during any user servicing operation and are likely to become energized shall be reliably connected to the means for grounding. Hinged or pivoting joints are not considered acceptable for bonding unless they are provided with an additional conductive connection, such as a bonding jumper. Rotating motor components that have metal-to-metal bearing surfaces are not required to have additional means of bonding.

4.16.4 The following are considered acceptable means for grounding:

- a) In an appliance intended to be permanently connected by a metal-enclosed wiring system – a knockout or equivalent opening in the metal enclosure of the appliance. See Clause [4.5.5.1.1](#);
- b) In an appliance intended to be permanently connected by a nonmetal-enclosed wiring system, for example, nonmetallic sheathed cable – an equipment-grounding terminal or lead, see Clauses [4.5.5.2.2](#) and [4.5.5.2.4](#); and
- c) In a cord-connected appliance – an equipment-grounding conductor in the cord.

4.16.5 The grounding conductor of a flexible cord shall be green with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure of the appliance by means of a screw that is not likely to be removed during any servicing operation not involving the power-supply cord, or by other equivalent means. A quick-connect terminal with a detent as a means for latching mating parts and a current-carrying capacity at least equivalent to that of the current-carrying conductors of the flexible cord is considered to be equivalent means. Solder alone shall not be used for securing the grounding conductor. The grounding conductor shall be connected to the fixed member of a grounding-type attachment plug, except that the grounding member of the plug on a portable hand-guided or supported appliance may be of the movable, self-restoring type. Servicing as mentioned in this Clause includes repair of the appliance by a qualified service person.

4.16.6 A separable connecting device provided with a grounding connection shall be such that the equipment-grounding connection is made before connection to and broken after disconnection from the supply circuit.

Exception: Interlocked plugs, receptacles, and connectors that are not energized when the equipment-grounding connection is made.

4.16.7 If an appliance is intended to be grounded and is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

4.16.8 An appliance marked as being provided with double insulation shall not be provided with a means for grounding.

4.16.9 A double-insulated motorized nozzle may be employed with a vacuum cleaner having a means for grounding provided the nozzle is marked in accordance with item 8 of [Table 18](#).

4.16.10 Permanently connected appliances, including central vacuum cleaners, shall have provision for grounding. Double insulation shall not be used in lieu of grounding.

4.17 Protective devices

4.17.1 The screw shell of a plug type fuseholder and the cap end of an extractor post type fuseholder shall be connected toward the load.

4.17.2 A protective device, such as a fuse, the normal function of which requires renewal or replacement, shall be in a readily accessible location, other than as noted in Clause [4.17.4](#).

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

Exception: The operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts may project outside the appliance enclosure.

4.17.4 The protective device mentioned in Clause [4.17.2](#) need not be in a readily accessible location if:

- a) The appliance, with the protective device shunted out of the circuit, would comply with all applicable requirements in this standard; and
- b) The presence of the protective device would ordinarily be unknown to the user of the appliance because of its location and the omission of reference to the device in the operating instructions, circuit diagram, and the like for the appliance.

4.17.5 Fuses shall comply with C22.2 No. 248.1 and UL 248-1, and the applicable Part 2 (e.g., C22.2 No. 248.5 and UL 248-5). Defined use fuses that comply with C22.2 No. 248.1 and UL 248-1, and another appropriate CSA and UL standard for the fuse are considered to fulfill this requirement.

Exception: Electronic overcurrent protection shall be evaluated in accordance with Clause [4.11.4](#).

4.17.6 Fuseholders that are accessible to the user shall comply with C22.2 No. 4248.1, UL 4248-1, and the applicable Part 2 (e.g., C22.2 No. 4248.9 and UL 4248-9).

4.17.7 Supplementary protectors that function in that capacity shall comply with C22.2 No. 235 and UL 1077.

Exception: Electronic supplementary protection shall be evaluated in accordance with Clause [4.11.4](#).

4.17.8 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with C22.2 No. 144.1 and 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."

4.17.9 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with UL 943B or CSA C22.2 No. 270.

Exception: An ALCI is not considered an acceptable substitute for a GFCI when C22.1 or ANSI/NFPA 70 requires a GFCI.

4.17.10 Equipment ground-fault protective devices shall comply with C22.2 No. 144.1 and UL 1053, and the applicable requirements of C22.2 No. 144.1 and UL 943.

4.17.11 When required by this end-product standard, an arc-fault circuit-interrupter (AFCI) or leakage-current detector-interrupter (LCDI) shall be installed as an integral part of the attachment plug or located in the supply cord within 102 mm (4 in) of the attachment plug.

4.17.12 Arc-fault circuit-interrupters (AFCI) shall comply with UL 1699 or CSA No. 270.

4.17.13 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with UL 1699 or CSA No. 270.

4.17.14 Arc fault detection testing shall include the applicable UL 1699 or CSA No. 270 tests required for cord-type arc-fault circuit-interrupters.

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

4.17.15 An AFCI or LCDI provided as part of an appliance intended for outdoor use shall comply with the applicable outdoor use requirements of this end product standard.

4.18 Heating elements – Vacuum with steam-cleaning attachment

4.18.1 A heating element used in a vacuum cleaner with a steam-cleaning attachment shall comply with the applicable requirements of C22.2 No. 72, and UL 1030 or UL 499. Aluminum sheathed elements shall not be used.

4.18.2 A heating element shall be supported in an acceptable manner. It shall be protected against mechanical damage and contact with outside objects.

4.18.3 In determining whether a heating element is acceptably supported, consideration shall be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating.

4.18.4 Appliances intended to heat liquids that can be inadvertently operated when dry shall be provided with a protective device or devices that will open the power supply or reduce the power input to the heating element to prevent unsafe temperatures from being attained when the appliance is operated at the test voltage under such abnormal conditions. Heating elements shall not be considered as protective devices.

4.19 Thermal links

4.19.1 The thermal link shall comply with the applicable requirements of CAN/CSA-E60691 and UL 60691.

4.19.2 The thermal link shall be capable of opening the circuit in the intended manner without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure when the appliance is connected to a circuit of voltage in accordance with Clause [5.1](#) and operated in a normal position to cause abnormal heating.

4.19.3 To determine compliance with Clause [4.19.2](#), the appliance shall be operated five times as described in Clause [4.19.2](#) with separate thermal links. During this test any other thermally operated control devices in the product shall be short-circuited. Each of the five thermal links is required to perform acceptably. During the test, the enclosure shall be connected through a 3-A fuse to a supply conductor not containing the thermal link.

4.20 Protection against injury to persons

4.20.1 General

4.20.1.1 If the operation and maintenance of an appliance by the user involves a risk of injury to persons, protection shall be provided to reduce the risk.

4.20.1.2 When judging an appliance with respect to the requirement in Clause [4.20.1.1](#), consideration shall be given to reasonably foreseeable misuse of the appliance.

4.20.1.3 The adequacy of a guard, a release, an interlock, and the like, and whether such a device is required, shall be determined from an investigation of the complete appliance, its operating characteristics, and the likelihood of a risk of injury to persons resulting from a cause other than gross negligence. The investigation shall include consideration of the results of breakdown or malfunction of any one component, but not more than one component at a time, unless one event contributes to another. If the investigation shows that breakdown or malfunction of a particular component can result in a risk of injury to persons, that component shall be investigated for reliability.

4.20.1.4 Specific constructions, tests, markings, guards, and the like are detailed for some common designs. Specific features and appliances not covered shall be given appropriate consideration. See marking, Clause [11](#).

4.20.2 Sharp edges

4.20.2.1 An enclosure, a frame, a guard, a handle, or the like shall not be sufficiently sharp to constitute a risk of injury to persons during normal maintenance and use.

Exception: This requirement does not apply to a part or portion of a part needed to perform a working function, such as a pet grooming tool that has an exposed metal-toothed blade.

4.20.2.2 Whenever referee measurements are necessary to determine that a part as mentioned in Clause [4.20.2.1](#) is not sufficiently sharp to constitute a risk of injury to persons, the method described in UL 1439 shall be used.

4.20.3 Enclosures and guards

4.20.3.1 The rotor of a motor, a pulley, a belt, a gear, a fan, or other moving part that could cause injury to persons shall be enclosed or provided with other means to reduce the likelihood of unintentional contact. An opening in an enclosure or guard shall comply with either (a) or (b).

a) For an opening that has a minor dimension less than 34.9 mm (1.375 in), such a moving part shall not be contacted by the probe illustrated in [Figure 2](#). See Clause [4.2.5.5](#) and Annex [A](#).

b) For an opening that has a minor dimension of 34.9 mm (1.375 in) or more, such a moving part shall not be contacted by the probe illustrated in [Figure 25](#) and [Figure 26](#). See Clause [4.2.5.5](#) and Annex [A](#).

Exception No. 1: A moving part or portion of a moving part that is necessarily exposed to perform the work function need not be enclosed but, when necessary, guarding shall be provided.

Exception No. 2: An opening in the integral enclosure of a motor employed in an appliance intended for commercial use, that is not used in either a hand-held appliance or a hand-supported portion of an appliance, is acceptable if a moving part cannot be contacted by the probe illustrated in [Figure 4](#).

Exception No. 3: An electronically controlled motor-driven brush that is necessarily exposed to perform its work function shall be marked in accordance with Clause [11.4.15](#).

4.20.3.2 During the examination of an appliance to determine whether it complies with the requirements in Clause [4.20.3.1](#), a part of the enclosure that can be removed without the use of a tool (to attach an accessory, to make an operating adjustment, or for other reasons) shall be opened or removed.

Exception: A part need not be opened or removed if it is marked in accordance with Clause [11.4.14](#).

4.20.3.3 During the examination of a central vacuum cleaner or a dust extraction system to determine whether the appliance complies with the requirements in Clause [4.20.3.1](#), all the attachments and fittings recommended in the installation manual shall be installed as intended. For a central vacuum marked in accordance with Clause [11.3.12](#), the exhaust piping shall also be in place during this examination.

4.20.3.4 With respect to both intended operation of the appliance and reasonably foreseeable misuse, a moving part that may involve a risk of injury to persons shall be considered with respect to:

- a) The degree of exposure necessary to perform the intended function;
- b) The sharpness of the moving part;
- c) The likelihood of unintentional contact;
- d) The speed of the moving part; and
- e) The likelihood that a part of the body would be endangered or clothing would become entangled by the moving part.

4.20.3.5 An enclosure or guard over a moving part shall retain:

- a) A part that, because of breakage or other reasons, can become loose or can separate from the moving part; and
- b) A foreign object that can be struck and propelled by the part.

4.20.3.6 A self-restoring polymeric movable guard provided in the front of a motorized nozzle (motorized driven brush) shall self-restore to the fully closed position, shall be marked in accordance with Clause [11.4.32](#) and shall be subjected to the following tests. As a results of the tests, the guard shall function as intended.

- a) Ball impact test in accordance with Clause [5.19.3](#);
- b) Mold stress-relief distortion test in accordance with Clause [5.21.3](#); and
- c) Mechanical endurance test consisting of 6000 cycles of operation. One cycle is considered to be moving the guard from the fully closed position to the fully open position and then back to the fully closed position. The cycle rate shall be a minimum of 6 cycles per minute.

4.20.4 Surface temperatures

4.20.4.1 During the temperature test, Clause [5.8](#), the temperature of a surface that can be contacted by the user shall not be more than the value specified in [Table 7](#). If the test is conducted at a room temperature of other than 25°C (77°F), the results shall be corrected to that temperature.

4.20.4.2 For a vacuum with a steam-cleaning attachment, the temperature of a surface that is likely to be contacted by the user shall not be more than the value specified in [Table 7](#) when measured in accordance with the applicable requirements in the Temperature Test, Clause [5.8](#).

Exception: Accessible surfaces, other than handles or knobs, may have temperatures that exceed those shown in [Table 7](#) if marked in accordance with Clause [11.4.26](#).

4.20.5 Stability

4.20.5.1 A portable appliance of the water-containing type, including a vacuum cleaner with a steam-cleaning attachment, or the wet pick-up type shall be tested as described in stability, Clause [5.13](#), and shall not overturn.

Exception: An upright-type appliance that is hand guided while in use is not required to be tested. An upright-type appliance provided with facilities for non-hand guided operation, such as a hose, shall be tested with the appliance arranged for such non-hand guided operation.

4.20.6 Strength of handles

4.20.6.1 A handle used to carry an appliance shall withstand a force of four times the empty weight of the appliance without damage to the handle, its securing means or that portion of the enclosure to which the handle is attached. See strength of handles, Clause [5.20](#).

4.20.7 Interlocks, switches, and controls

4.20.7.1 An appliance shall be constructed so as to reduce the likelihood of unexpected operation of any parts capable of causing injury to persons.

4.20.7.2 Each function of a multiple-function appliance shall be taken into consideration in determining whether the appliance complies with the requirement in Clause [4.20.7.1](#).

4.20.7.3 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.

4.20.7.4 With reference to Clause [4.20.7.3](#), a switch shall be considered to be located or guarded so that unintentional operation is unlikely if it is:

a) Mounted in an upright vacuum cleaner or motorized nozzle (including the hose or wand) and the switch is not actuated when the appliance is placed on both flat carpeted and noncarpeted surfaces in any position in which the rotating brush is accessible for maintenance. During this examination, the appliance may be moved around on, but is not to be lifted from, the surface. The carpeting shall be as described in Clause [5.2.1.2](#); or

b) Located on a canister vacuum cleaner that controls the motorized nozzle.

4.20.7.5 The actuator of a switch may be guarded by recessing, ribs, barriers, or the like.

4.20.7.6 Automatic-reset types of protective devices shall not be used in appliances if the automatic restarting of the appliance could result in any risk of fire, electric shock, or injury to persons.

4.20.7.7 The requirement in Clause [4.20.7.6](#) necessitates the use of an interlock in an appliance if moving parts or the like are likely to present a risk of injury to persons upon automatic starting of the appliance. Electromechanical interlock controls shall also comply with Clause [4.11.4.4](#), and electronic interlocks shall comply with Clause [4.11.4](#).

4.20.7.8 The actuator of an interlock shall be located so that unintentional operation is unlikely.

4.20.7.9 Operation of an interlock during use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

4.20.7.10 An interlock shall not be likely to be defeated by materials that could accumulate during use of the appliance.

4.20.7.11 An interlock shall be such that it can only be defeated by:

- a) Damaging the appliance;
- b) Making wiring connections or alterations; or
- c) Using materials that are not readily available.

4.20.7.12 If an interlock is actuated by movement of a guard, the arrangement shall be such that the guard is in place when the interlock is in the position that permits operation of the parts being guarded. With the guard removed, the interlock shall comply with the requirement in Clause [4.20.7.8](#).

4.20.8 Blower Cleaner Impellers

4.20.8.1 The impeller of a blower cleaner shall have the necessary strength and rigidity to resist the abuses likely to be encountered during normal service.

4.20.8.2 The blower cleaner shall be tested as described in blower cleaner impeller tests, Clause [5.28](#), without parts of the impeller being ejected from the blower, without cracks or other damage to the impeller that are visible to the naked eye upon inspection, and without the occurrence of any other condition that would increase the risk of injury to persons resulting from operation of the blower.

4.20.8.3 The visual inspection described in Clause [4.20.8.2](#) indicates a visual inspection conducted without using a device to magnify the area in question, by a person with normal vision (1x vision) or corrected to normal vision.

4.20.9 Parts subject to pressure – Vacuum with steam-cleaning attachment

4.20.9.1 A part that is subject to steam pressure during normal or abnormal operation shall withstand without bursting or leaking a pressure equal to the highest of the following that is applicable:

- a) Five times the pressure corresponding to the maximum setting of a pressure-reducing valve provided as part of the assembly, but not more than five times the pressure setting of a pressure-relief device provided as part of the assembly.
- b) Five times the pressure setting of a pressure-relief device provided as part of the assembly.
- c) Five times the working pressure marked on the part.

4.20.9.2 To determine compliance with Clause [4.20.9.1](#), two samples of the part shall be subjected to a hydrostatic-pressure test. Each sample shall be filled with water so as to exclude air and shall be connected to a hydraulic pump. The pressure shall be raised gradually to the specified test value and shall be held at that value for 1 min. The sample shall not burst or leak, except as indicated in Clause [4.20.9.3](#).

4.20.9.3 Leakage at a gasket during the hydrostatic-pressure test is acceptable if it does not occur at a pressure 40% or less of the required test value.

4.20.9.4 A vessel having an inside diameter of more than 76.2 mm (3.0 in) and subject to steam pressure generated or stored within the product shall be protected by a pressure-relief device.

4.20.9.5 The start-to-discharge pressure setting of the pressure-relief device of Clause [4.20.9.4](#) shall not be higher than the working pressure marked on the vessel. The discharge rate of the device shall be capable of relieving the pressure.

4.20.9.6 The pressure-relief device of Clause [4.20.9.4](#) shall comply with all four of the following:

- a) It shall be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect.
- b) It shall be so installed that it is readily accessible for inspection and repair and cannot be readily rendered inoperative.
- c) It shall have its discharge opening so located and directed that the risk of scalding is reduced to a minimum.
- d) It shall have its discharge opening so located and directed that operation of the device will not deposit moisture on bare live parts or on insulation or components affected by moisture.

4.20.9.7 A pressure-relief device having an adjustable setting is judged on the basis of its maximum setting unless the adjusting means is sealed at a lower setting.

4.20.9.8 A pressure-relief device is considered to be a pressure-actuated valve or rupture member constructed to relieve excessive pressures automatically.

4.20.9.9 Where a pressure-relief device is required, the control responsible for limiting the pressure in the vessel shall be capable of performing under rated load for 100,000 cycles of operation, and the control shall limit the pressure so that it does not exceed 90% of the relief device setting under any condition of intended operation.

4.20.10 Floor sweepers

4.20.10.1 With reference to Clause [4.20.7.3](#), a switch is considered to be located or guarded so that unintentional operation is unlikely if it is mounted in the floor sweeper and the switch is not actuated when the floor sweeper is placed on both a flat hard surface and flat carpeted surface in any position in which the rotating brush is accessible for maintenance. During this examination, the floor sweeper may be moved around on, but is not to be lifted from, the surface. For the carpeted surface, the carpeting shall be as described in Clause [5.2.1.2](#).

4.20.10.2 If the rotating brush is partially exposed for the floor sweeper to perform its work function, and the rotating brush is considered to be a hazardous moving part, the appliance shall be marked in accordance with Clause [11.4.29](#).

4.20.10.3 A tool shall be required to remove the dirt container of the floor sweeper if removal of the dirt container exposes the user to:

- a) Hazardous moving or rotating part(s); or
- b) Any normally enclosed or protected uninsulated live parts or internal wiring.

Exception: A floor sweeper provided with an interlock system that complies with Clause [4.20.10.5](#) does not need to comply with this requirement.

4.20.10.4 With reference to Clause [4.20.10.3](#), a floor sweeper provided with a removable dirt container that requires a tool for removal shall be marked in accordance with Clause [11.4.30](#).

Exception: A floor sweeper provided with an interlock system that complies with Clause [4.20.10.5](#) is not required to have this marking.

4.20.10.5 An interlock system provided with a floor sweeper shall:

- a) Disconnect power to the motor after the dirt container is removed;
- b) Disconnect power to any uninsulated live parts or internal wiring that become accessible after the dirt container is removed;
- c) Comply with the interlock switch requirements in Clauses [4.20.7.8](#) – [4.20.7.12](#);
- d) Comply with the Interlock System Endurance Test in Clause [5.33](#); and
- e) Comply with the interlock switch requirements in Clauses [4.20.7.8](#) – [4.20.7.12](#) after the ball impact test in Clause [5.19.3](#), if the interlock system uses polymeric materials in its construction. A floor sweeper provided with a removable polymeric dirt container that is part of an interlock system shall comply with the ball impact test with the dirt container removed and with it installed as intended in the floor sweeper. After the impact testing, there shall be no malfunction of the interlock system.

5 Tests

5.1 General

5.1.1 The appliance shall be subjected to the applicable tests for the type of appliance and its application.

5.1.2 Unless otherwise specified, the test voltage shall be as specified in [Table 8](#) and maintained at that voltage throughout the test.

5.1.3 An appliance rated ac/dc or dc-60 Hz shall be tested on direct current or 60 Hz alternating current, whichever results in the most unfavorable operating conditions for the particular test.

5.1.4 For appliances provided with instructions for the user to fill a liquid tank or reservoir with hot water (such as a carpet cleaning machine), for the Temperature Test, the tank or reservoir shall be filled with water at a temperature of 60°C (140°F).

5.2 Normal loads

5.2.1 General

5.2.1.1 Normal load shall be considered to be that load which approximates as closely as possible the most severe conditions of normal use but is not a deliberate overload. Test loads that have been found to be close approximations of the most severe conditions of normal use are indicated in Clauses [5.2.2](#) – [5.2.9](#) for some common forms of appliances. However, appliances having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements. A multifunction appliance shall be tested individually for each applicable normal load.

5.2.1.2 The carpet employed for tests shall have the physical characteristics of the level loop test carpet construction described in ASTM F 655. A carpet that provides equivalent performance characteristics for the test being conducted may be used in place of this test carpet. The carpet shall be installed over sponge rubber padding with the physical characteristics described in ASTM F 655. See Annex [E](#) for the specifications.

5.2.1.3 For the tests, the appliance shall be operated continuously with a clean dust bag or filter, if provided, in place. For each condition, the appliance shall be operated until constant temperatures are attained.

5.2.1.4 With the air inlet unobstructed, any device that ensures a flow of air to cool the motor in the event of a blockage of the main air inlet shall be allowed to operate. With the air inlet blocked, any device that is adjustable without the aid of a tool, and which ensures a flow of air to cool the motor in the event of a blockage of a main air inlet, shall be rendered inoperative.

Exception: A mechanical air-flow valve or similar device that complies with the mechanical valve endurance test in Clause [5.31](#) shall be allowed to operate during the Temperature test.

5.2.2 Portable vacuum cleaners

5.2.2.1 The vacuum cleaner shall be operated with the air intake closed off sufficiently to maintain a mean wattage input to the appliance; see also Clause [5.8.2](#). For upright type vacuum cleaners provided with an integral port for connection of above floor cleaning tools, this attachment port shall be used for this test condition. See Clause [5.2.2.2](#).

5.2.2.2 Mean wattage input is the mathematical average of the wattage input noted with the air intake wide open and with the air intake completely blocked. All inputs shall be noted on an appliance operated until thermal equilibrium with any detachable hose removed. The wattage input for the intake sealed condition shall be noted 15 – 20 s after the intake has been completely closed off. The method of closing shall not impose a mechanical load on the movement of a brush, if provided. If an appliance employs a mechanical valve that operates under the blocked inlet condition, the valve shall be prevented from functioning. If agreeable to those concerned, a non-detachable hose may be removed for this test, and a detachable hose shall remain attached if air recirculation could occur.

Exception No. 1: For appliances that cannot be operated with the current-carrying hose detached, the hose shall remain attached.

Exception No. 2: A mechanical air-flow valve that functions during the blocked inlet condition shall comply with the endurance test requirements specified in Clause [5.31](#).

5.2.2.3 A vacuum cleaner intended for use with a motorized nozzle shall be additionally operated while connected to a motorized nozzle that is operated as described in Clause [5.2.4.1](#).

5.2.2.4 A vacuum cleaner employing a motor-driven brush (or similar device) shall be additionally operated on the test carpet described in Clause [5.2.1.2](#). During operation, the product shall be moved forward and backward on the carpet simulating normal use. If a carpet height adjustment is provided, it shall be adjusted in accordance with the instructions provided with the product to the lowest position for the test carpet.

5.2.2.5 A vacuum cleaner that has provision to be operated as a blower shall be additionally operated as specified in Clause [5.2.5](#).

5.2.2.6 A dust collector shall be operated with the air intake completely opened. When the product employs a flow-thru type motor, where ventilating air is dependent on the working air flow, the product shall be additionally tested in accordance with Clause [5.2.2.1](#).

5.2.3 Central vacuum cleaners

5.2.3.1 A central vacuum cleaner shall be mounted in the intended manner in a 9.5-mm (3/8-in) thick, black-painted plywood corner alcove consisting of a floor, a 90° wall angle formed by two vertical plywood

sheets, and an 2.44-m (8-ft) high ceiling with all surfaces of the alcove extending not less than 0.61 m (2 ft) beyond the physical limits of the appliance. The appliance shall be located as close to the walls and to the floor or ceiling as its construction will allow unless marked in accordance with Clauses [11.3.10](#), [11.3.11](#) or [11.3.12](#), as applicable. Other than as noted in Clause [5.2.3.2](#), the exhaust opening shall be pointed in the direction that results in maximum temperatures on the appliance. The inlet of the central vacuum cleaner shall be piped 22.9 ± 7.6 cm (9 ± 3 in) beyond the alcove. The appliance shall be operated with the air intake blocked off sufficiently to maintain a mean wattage input to the appliance. See Clause [5.2.2.2](#).

5.2.3.2 If a central vacuum cleaner is provided with a means for connecting an outdoor exhaust and is marked in accordance with Clause [11.3.12](#), the exhaust piping shall be in place during the test described in Clause [5.2.3.1](#).

5.2.4 Motorized nozzles

5.2.4.1 A motorized nozzle, with a vacuum cleaner attached, shall be operated continuously until constant temperatures are reached. While operating, the nozzle shall be moved forward and backward, simulating normal use over a carpet as described in Clause [5.2.1.2](#). If the motorized nozzle has a carpet-height adjustment, it shall be adjusted in accordance with the manufacturer's instructions to the lowest position for the test carpet.

5.2.4.2 For motorized nozzles intended as stand-alone devices, the input rating of the vacuum cleaner providing air flow shall not be less than 750W.

5.2.4.3 Motorized nozzles intended as stand-alone equipment shall be operated continuously until constant temperatures are reached. While operating, the nozzle shall be moved forward and backward, simulating normal use over a carpet as described in Clause [5.2.1.2](#). If the motorized nozzle has a carpet-height adjustment, it shall be adjusted in accordance with the manufacturer's instructions to the lowest position for the test carpet.

5.2.5 Blower cleaners

5.2.5.1 A blower cleaner and a vacuum cleaner that has provision to also operate as a blower shall be operated with the air intake and exhaust completely open and without a hose, fitting, or blower tube connected, unless such hose, fitting, or tube is required to activate the blower operation. For an appliance, where the cooling air is dependent on the working air flow, the appliance shall be additionally operated with the tube or accessory attached to result in the maximum air restriction. Operation shall continue until constant temperatures are attained for each condition.

5.2.5.2 A blower cleaner provided with a connector base (motor-attachment plug cap) or a power-supply cord 457-mm (18-in) long or less shall be connected to the source of supply using a 7.62-m (25-ft) long cord set. The cord set shall be the minimum gauge size for use with the product's rating.

5.2.6 Household floor finishing machines

5.2.6.1 Each household floor finishing machine shall be tested on a previously polished composition-tile surface in the operation for which it is intended that produces maximum intended load for 1 h of continuous operation, or until constant temperatures are attained, whichever is less.

5.2.7 General-use receptacles

5.2.7.1 For a cord-connected, portable, utility vacuum cleaner provided with general-use receptacle(s) in which the vacuum and the receptacles cannot be energized at the same time, the vacuum shall be additionally operated with the receptacles connected to a resistive load equal to the applicable total receptacle load value given in [Table 28](#); see Note b of [Table 28](#).

5.2.7.2 For a vacuum cleaner where the vacuum and receptacles can be energized at the same time, the vacuum shall be operated with the receptacle(s) loaded with the intended ampere load; see Clause [11.1.6](#).

5.2.8 Vacuums with steam-cleaning attachment

5.2.8.1 The normal load for the vacuum mode shall be in accordance with Clauses [5.2.1](#) and [5.2.2](#), and the normal load for the steam-cleaning mode shall be in accordance with Clauses [5.2.8.2](#) – [5.2.8.6](#).

5.2.8.2 The test voltage to the steam-cleaning attachment shall be adjusted in accordance with Clause [5.2.8.3](#). The voltage to the motor operated part of the appliance shall be in accordance with Clause [5.1.2](#). The appliance shall be operated continuously, unless the appliance has a water reservoir that needs to be refilled before constant temperatures are obtained. Then the reservoir shall be refilled in accordance with the instruction manual as often as needed until constant temperatures are obtained.

5.2.8.3 The test voltage specified in Clause [5.1.2](#) shall be adjusted to compensate for appliances that, when tested as specified in Clause [5.2.8](#), have an input less than the marked input. The test voltage shall be adjusted to result in a current or power input equal to one of the following, whichever results in the highest input:

a) $W_m(125 / V_m)^2$ or $W_m(250 / V_m)^2$ Where W_m is the marked input in watts and V_m is the marked voltage, and 125 and 250 represent the maximum normal voltages of the system on which the appliances are intended to operate.

b) Voltage increased to cause the current or wattage input to be equal to the marked steam-cleaning current or wattage rating.

5.2.8.4 If the vacuum can be operated in vacuum cleaning mode and steam-cleaning mode simultaneously, the appliance shall be operated in both mode simultaneously until constant temperatures are obtained. If the vacuum cannot be operated in both modes simultaneously, then the appliance shall be operated in each mode separately. After constant temperatures are obtained in the first mode, the second mode of operation shall be immediately initiated, and the appliance shall be operated until constant temperatures are obtained.

5.2.8.5 An automatic temperature-regulating or -limiting control or other protective device shall be shunted out of the circuit, unless the control has been shown, in accordance with Clause [5.30](#) and [Table 22](#), to be reliable, and unlikely to be defeated by the user. The control shall be considered to be unlikely to be defeated if tools are required to gain access to the control, or a positive stop is incorporated in the control.

5.2.8.6 The steam-cleaning attachment shall be supported on two layers of white tissue paper on a softwood surface during the temperature test.

5.2.9 Floor sweepers

5.2.9.1 A floor sweeper shall be operated on the test surfaces described in Clauses [5.2.9.2](#) – [5.2.9.4](#). During operation, the appliance shall be moved forward and backward on the surface simulating normal use. If the appliance has a height adjustment (e.g. carpet-height adjustment), the height shall be adjusted in accordance with the manufacturer's instructions to the lowest position for the test surface.

5.2.9.2 Floor sweepers intended for use on a hard surface shall be tested on a previously polished composition-tile floor.

5.2.9.3 Floor sweepers intended for use on a carpeted surface shall be tested on a carpet as described in Clause [5.2.1.2](#).

5.2.9.4 Floor sweepers intended for use on hard and carpeted surfaces shall be tested on both of the test surfaces specified in Clauses [5.2.9.2](#) and [5.2.9.3](#).

5.3 Leakage current

5.3.1 The leakage current of a single-phase cord-connected appliance when tested in accordance with Clauses [5.3.3](#) – [5.3.6](#) shall not be:

- a) More than 0.5 MIU for an ungrounded, 2-wire, portable appliance;
- b) More than 0.5 MIU for a grounded, 3-wire, portable appliance;
- c) More than 0.75 MIU for a grounded, 3-wire, stationary appliance employing a standard attachment plug rated 20 A or less; or
- d) More than that specified in Clause [6.12](#) for an appliance marked to indicate that it employs double insulation. See Clause [11.3.8](#).

Exception: For a vacuum cleaner with steam-cleaning attachment that uses a sheath-type heating element, while in the steam-cleaning mode and during heat-up and cool-down, the leakage current may exceed 0.5 MIU or 0.75 MIU for a grounded appliance, or 0.25 MIU or 0.5 MIU for a double insulated appliance, as applicable, but shall not exceed 2.5 MIU during a period of 5 minutes beginning with the moment the leakage current exceeds 0.5 MIU or 0.75 MIU, or 0.25 MIU or 0.5 MIU, as applicable. At the end of the 5 minute period, the leakage current shall not be more than 0.5 MIU or 0.75 MIU, or 0.25 MIU or 0.5 MIU, as applicable.

5.3.2 Leakage current refers to all currents, including capacitively coupled currents, that can be conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

5.3.3 All exposed conductive surfaces shall be tested for leakage currents. The leakage currents from these surfaces shall be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts shall be considered to be exposed surfaces unless guarded by an enclosure considered acceptable to reduce a risk of electric shock. Surfaces shall be 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 extra low voltages that are not considered to involve a risk of electric shock.

5.3.4 If a surface other than metal is used for the enclosure or part of the enclosure, the leakage current shall be measured using a metal foil with an area of 10 by 20 cm (3.9 by 7.8 in) in contact with the surface. Where the surface is less than 10 by 20 cm (3.9 by 7.8 in), the metal foil shall be the same size as the surface. The metal foil shall not remain in place long enough to affect the temperature of the appliance.

5.3.5 The measurement instrument shall be as described in UL 101, and if applicable, shall be set to reaction mode. The measurement circuit shall be as illustrated in [Figure 6](#).

5.3.6 The sample shall be at room temperature at the start of the test. It shall be energized and operated under conditions of normal load described in Clause [5.2](#) until thermal stabilization is obtained. Before, during and after this operation, the leakage current shall be monitored. Appliances with controls for speed, temperature, and the like shall be tested with such controls in all of their various operating positions. For the test, the leakage current shall be noted using both positions of switch S2 and with switch S1 both open and closed.

5.3.7 The grounding conductor of cord-connected equipment shall not be connected to ground except through the test meter.

5.3.8 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the resistors shall be shorted one at a time during the test.

5.4 Leakage current following humidity conditioning

5.4.1 A cord connected appliance shall comply with the requirements for leakage current, Clause [5.3](#), following conditioning for 48 h in moist air having a relative humidity of $88 \pm 2\%$ at a room temperature of $32.0 \pm 2.0^\circ\text{C}$ ($89.6 \pm 3.6^\circ\text{F}$):

- a) The appliance shall be at a temperature just above the test chamber temperature when it is placed in the humidity chamber;
- b) The appliance shall remain in the humidity chamber for 48 h;
- c) Following this exposure, while still in the test chamber, the sample shall be tested unenergized (that is, switch S1, open);
- d) The sample shall then be tested energized, except that the test may be discontinued when the leakage current has stabilized or decreased.

5.4.2 This test may be conducted in the humidity chamber or immediately after the sample has been removed from the humidity chamber.

5.4.3 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the resistors shall be shorted one at a time during the test.

5.5 Leakage current – Abnormal operating conditions

5.5.1 During and after operation as described in Clauses [5.5.2](#) – [5.5.4](#), the leakage current of a portable, cord connected, vacuum cleaner or motorized nozzle shall not exceed 5.0 MIU.

5.5.2 For each applicable operating condition in Clauses [5.5.3](#) and [5.5.4](#), each sample of the appliance shall be tested for leakage current starting with the as-received condition. Following this, each sample shall be subjected to each applicable operating condition as described in Clauses [5.5.3](#) and [5.5.4](#) while being monitored continuously for leakage current. The power to the appliance shall be controlled by a remote switching device. The leakage current shall be evaluated using the method described in Clauses [5.3.3](#) – [5.3.7](#).

5.5.3 Three samples of an appliance shall be subjected to the applicable operating condition in (a) or (b):

- a) For an appliance having a rotating agitator, operation for 30 s with the agitator locked in place; or
- b) For an appliance having a dirty-air-fan system, operation for 30 s with the dirty-air-fan locked in place.

5.5.4 One sample of an appliance shall be operated for 1 min with the intake port on the body of the appliance completely sealed off – the port shall be sealed so as not to impede the movement of a brush or otherwise impose a mechanical friction load on the appliance.

5.5.5 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the resistors shall be shorted one at a time during the test.

5.6 Starting current

5.6.1 An appliance shall start and operate normally on a circuit protected by an ordinary – not time-delay – fuse having a current rating corresponding to that of the branch circuit to which the appliance should be connected. During the test in Clause [5.6.2](#), the fuse shall not open or an overload protector provided as part of the appliance shall not trip.

Exception: A time-delay fuse may be used, as provided in Clause [5.6.3](#).

5.6.2 To determine whether an appliance complies with the requirement in Clause [5.6.1](#), the appliance shall be started three times under conditions of normal load as described in Clause [5.2](#), with the appliance at room temperature at the beginning of the test. Each start of the motor shall be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle, in the case of an automatic appliance – and the motor shall be allowed to come to rest between successive starts.

5.6.3 For the test in Clause [5.6.2](#), a time-delay fuse may be employed if all of the following are met:

- a) The construction of the appliance or the nature of its usage is such that it is likely to be used continually on the same branch circuit after installation;
- b) The appliance will start and operate normally on a circuit protected by a time-delay fuse; and
- c) The appliance is marked in accordance with Clause [11.3.5](#).

5.7 Rating

5.7.1 The input current in amperes (and watts, if so marked) to the appliance shall not vary from the marked current (and wattage) rating by more than plus 10% and minus 15% when the equipment is operated under normal load conditions, as described in Clause [5.2](#).

Exception No. 1: See Clause [5.7.3](#).

Exception No. 2: For a vacuum cleaner with a steam-cleaning attachment, the input current (and watts, if so marked) shall not vary from the marked current (and wattage) rating by more than plus 5% and minus 15% when the equipment is operated under the steam cleaner normal load conditions, as described in Clauses [5.2.8.2](#) – [5.2.8.6](#).

5.7.2 For a multifunction appliance, such as a vacuum-cleaner/motorized-nozzle combination, vacuum cleaner-blower, or the like, the input shall be based on the highest load when tested under all applicable conditions of normal load as described in Clause [5.2](#). See Clause [11.1.3](#).

5.7.3 Single-phase equipment having a rating not exceeding 3 A (and 250 W, if so marked) shall not exceed the marked amperes (and watts) input by more than 20%.

5.8 Temperature

5.8.1 An appliance shall be tested under the applicable conditions of normal load as described in Clause [5.2](#), and shall not attain a temperature at any point sufficiently high to constitute a risk of fire, to damage any materials employed in the appliance, or to exceed the temperature rises specified in [Table 9](#).

5.8.2 For portable vacuum cleaners, the mean wattage to the vacuum cleaner shall be monitored throughout the normal temperature test and when necessary, the restriction on the vacuum air inlet (orifice) shall be adjusted to maintain the required mean wattage input. See Clause [5.2.2.1](#).

5.8.3 All values for temperature rises in [Table 9](#) are based on an assumed ambient temperature of 25°C (77°F). Tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

5.8.4 If an appliance incorporates a reel for the power-supply cord, one-third of the length of the cord shall be unreeled for the temperature test.

5.8.5 If an appliance is obviously not intended for continuous operation, the temperature test may be conducted so that it will take into consideration the probable intermittent or short-time operation of the appliance.

5.8.6 Thermal equilibrium or constant temperature shall be considered to exist when three successive readings, taken at intervals of 10% of the previously elapsed duration of the test, but not less than 5-min intervals, indicate no increase.

5.8.7 Coil or winding temperatures shall be measured by thermocouples or by using the change-of-resistance method. For a thermocouple-measured temperature of a coil of an alternate-current motor having a diameter of 178 mm (7 in) or less and a universal motor, the thermocouple shall be mounted on the integrally applied insulation on the conductor. For any other motor, the thermocouple may be applied on the outer surface as a wrap that is not more than 0.8-mm (1/32-in) thick and consists of cotton, paper, rayon, or the like – but not of asbestos or similar thermal insulation.

5.8.8 Thermocouples shall consist of wires not larger than 24 AWG (0.21 mm²) and not smaller than 30 AWG (0.05 mm²). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of 30 AWG (0.05 mm²) iron and constantan wire and a potentiometer-type instrument; and such equipment shall be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire shall conform with the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in ANSI/ASTM E230/E230M.

5.8.9 In using the resistance method, the windings shall be at room temperature at the start of the test. The temperature rise of a winding shall be calculated from the formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

Where:

Δt is the temperature rise in °C;

R is the resistance of the coil at the end of the test in ohms;

r is the resistance of the coil at the beginning of the test in ohms;

t_1 is the temperature in °C of the coil at the time resistance " r " is being measured;

t_2 is the room temperature at the end of the test in °C; and

k is 234.5 for copper, 225.0 for electrical conductor grade (EC) aluminum. Values of the constant k for other grades must be determined.

5.9 Severe operating conditions

5.9.1 Extreme operating voltage

5.9.1.1 The appliance shall be operated under conditions of normal load, as described in Clause [5.2](#), while connected to the extreme operating voltages (high and low) specified in [Table 10](#). The normal load shall be established at the test voltage specified in [Table 8](#), then the voltage is adjusted for extreme operating voltage. During the test, temperatures shall be monitored on the motor. As a result of this operation, temperatures on motor insulation shall not exceed those specified in [Table 9](#) plus an additional 20°C (36°F) rise.

5.9.2 Central vacuum cleaners – Blocked and open inlet

5.9.2.1 A central vacuum cleaner shall be operated as described in Clause [5.9.2.2](#). The temperature of the windings of a Class A (105) insulated motor shall not exceed 140°C (284°F), of a Class B (130) insulated motor shall not exceed 165°C (329°F), and of a Class F (155) insulated motor shall not exceed 190°C (374°F).

5.9.2.2 To determine whether a central vacuum cleaner complies with the requirement in Clause [5.9.2.1](#), it shall be installed and operated as described in Clause [5.2.3.1](#), except that the air intake shall be firstly, completely closed off and, secondly, completely open.

5.10 Abnormal operation

5.10.1 General

5.10.1.1 Equipment shall not cause a risk of fire or electric shock when operating under the abnormal conditions specified in Clauses [5.10.2](#) – [5.10.7](#).

5.10.1.2 Operation under the abnormal conditions specified in Clauses [5.10.2](#) – [5.10.6](#) shall not result in a risk of fire or electric shock. A risk of fire or electric shock shall be considered to exist if the test results in any of the following:

- a) Ignition of the cheesecloth or the tissue paper;
- b) The 3 A fuse connected to earth ground opens;
- c) Any opening is developed in the overall enclosure that is larger than those permitted by accessibility requirements as covered by accessibility to live parts, Clause [4.2.5](#); or
- d) The appliance does not comply with the dielectric voltage-withstand test, Clause [5.11](#).

5.10.1.3 Following the applicable abnormal condition(s), the sample shall be subjected to the applicable dielectric voltage-withstand test, Clause [5.11](#).

5.10.1.4 For the abnormal operation tests specified in Clauses [5.10.2](#) – [5.10.7](#), the appliance shall be connected to a supply circuit protected by a 30-A time-delay fuse. It shall be placed on a white tissue paper covered softwood surface. A single layer of cheesecloth shall be draped loosely over the entire product. Exposed noncurrent-carrying metal parts shall be connected to earth ground through a 3-A nontime delay type fuse. The supply circuit connection shall be such that the maximum potential exists between the protective device of the product, if any, and the chassis.

5.10.2 Electronic components

5.10.2.1 A single malfunction (short or open) of any circuit component, such as a resistor, capacitor, solid state device, and the like, shall not result in an increased risk of fire or electric shock. For a discrete, multiple (more than two) terminal device, such as a transistor, SCR, triac, or an integrated circuit device, any combination of terminals taken two at a time shall be open- or short-circuited.

Exception: Abnormal operation testing of multiple terminal circuit devices may be reduced if it can be determined by circuit analysis that an open- or short-circuit of the terminal(s) is not likely to result in an increased risk of fire or electric shock.

5.10.2.2 The dielectric voltage-withstand test described in Clause [5.11](#) need be conducted only after the last abnormal operation test unless it is necessary to replace components after conducting the other tests.

5.10.3 Shorted electrical contact test

5.10.3.1 To determine compliance with Clause [5.10.1](#), the electrical contacts located on the underside of an electrical attachment shall be short-circuited, and then connected to the appliance as intended, before the appliance is energized. After the short-circuit is made, the appliance shall be energized.

5.10.4 Vacuums with steam-cleaning attachment – Abnormal dry operation

5.10.4.1 The vacuum, while in the steam-cleaning mode, shall be operated dry continuously, with all automatic temperature controls or protective devices shunted out of the circuit, except as noted in Clause [5.2.8.5](#), until ultimate results. If provided, low water sensing circuits not evaluated for reliability shall also be defeated. The steam cleaner part of the vacuum shall be placed on white tissue paper on a soft wood surface. As a result of this test, the appliance shall not increase the risk of fire or electric shock.

5.10.4.2 Unless otherwise indicated, the test shall be conducted in accordance with Clause [5.2.8](#). In most cases, continuous operation for 7 h will be necessary to determine the ultimate result.

5.10.4.3 In addition to compliance with Clause [5.10.1.2](#), the appliance shall be considered to involve a risk of fire if there is any emission of flame or molten metal, other than drops of melted solder, or if the operation of the product results in the glowing or flaming of combustible material upon which the product may be placed.

5.10.4.4 In addition to compliance with Clause [5.10.1.2](#), after having been subjected to the abnormal test in Clause [5.10.4.1](#), the appliance shall be considered to involve a risk of electric shock if the leakage current measured between an accessible part and ground exceeds 5 MIU. The reservoir of the steam cleaner's liquid container shall be filled with the hard-water solution described in Clause [5.12.4.2](#) in the intended manner, prior to the leakage current measurement. Water in an amount equal to the capacity of the container shall be poured into the reservoir and the leakage current shall be measured as quickly as possible thereafter.

5.10.5 Floor sweepers

5.10.5.1 A floor sweeper shall be operated under the abnormal condition of a stalled-rotor or stalled armature. The floor sweeper shall be operated continuously until the ultimate results have been determined. In most cases, continuous operation for 7 h will be necessary to obtain the ultimate results.

5.10.6 Printed wiring boards

5.10.6.1 To comply with Exception No. 3 of Clause [4.15.1.4](#), a printed wiring board shall be tested as described in Clauses [5.10.6.2](#) – [5.10.6.4](#).

5.10.6.2 During this test, if a printed wiring board trace opens, the gap shall be electrically shorted and the test continued until ultimate results occur. This applies to each occurrence. If the circuit is interrupted by the opening of a component, the test shall be repeated two more times using new components for each test.

5.10.6.3 A sample of the unit employing the printed wiring board shall be connected to its nominal rated supply circuit as specified in [Table 8](#). A foil trace shall be short-circuited to each of its adjacent traces that do not have the spacing specified in [Table 6](#) one at a time.

5.10.6.4 The test shall be continued for 1 h or until one of the conditions described in Clause [5.10.1.2\(a\)](#) – (c) occurs, or until the branch circuit or a supplementary protective device opens. However, if at the end of 1 h no condition described in Clause [5.10.1.2\(a\)](#) – (c) occurs, but indications are that such a condition could eventually occur, the test shall be continued until ultimate results are obtained (usually 7 h).

5.10.7 Motorized nozzles intended as stand-alone equipment

5.10.7.1 Motorized nozzles intended as stand-alone equipment shall be connected to the voltage supply with a 1.82 m (6 ft), 18 AWG SVT power cord with an additional resistance of 7.5 Ω in series, with each supply lead and operated with the agitator locked.

5.11 Dielectric voltage-withstand test

5.11.1 An appliance shall withstand for 1 min without breakdown the application of a 60-Hz essentially sinusoidal potential between live parts and dead metal parts – or between live parts of opposite polarity for a test on a capacitor as mentioned in (c) – with the appliance at the maximum operating temperature reached during intended use. Other than as noted in Clause [5.11.3](#), the test potential shall:

- a) Be 1000 V for an appliance employing a motor rated 1/2 hp (373 W output) or less;
- b) Be 1000 V plus twice the rated voltage for an appliance employing a motor rated more than 1/2 hp, or except as noted in (d), an appliance applied directly to persons or supported by the body of a person;
- c) Be 1000 V, or 1000 V plus twice rated voltage – depending upon the value of the test potential applied to the appliance as a whole – between the terminals of a capacitor used for radio-interference elimination or arc suppression;
- d) Be 2500 V for a wet pick-up appliance that is supported by the body of a person but not solely hand held; and
- e) Be as specified in dielectric voltage-withstand test, Clause [6.13](#), for an appliance marked to indicate that it employs double insulation. See Clause [11.3.9](#).

5.11.2 For applying Clause [5.11.1](#) to motors not rated in horsepower, reference shall be made to Clause [4.15.1.10](#).

5.11.3 If a transformer or an autotransformer is employed in the appliance, the test potential for the secondary circuit shall:

- a) Be 1000 V if the secondary operates at 51 – 250 V; or
- b) Be 500 V if the secondary operates at 50 V or less, except that this does not apply if the secondary circuit is supplied from a Class 2 transformer.

5.11.4 To determine whether an appliance complies with the requirements in Clauses [5.11.1](#) and [5.11.3](#), the appliance shall be tested by means of a 500 VA or larger transformer, the output voltage of which is essentially sinusoidal and can be varied. Starting at zero, the applied potential shall be increased until the required test value is reached, and shall be held at that value for 1 min. The increase in the applied potential shall be at a substantially uniform rate and as rapid as consistent with its values being correctly indicated by a voltmeter.

5.11.5 With reference to the requirement in Clause [5.11.4](#), a 500 VA or larger capacity transformer need not be used if the transformer is provided with a voltmeter to measure directly the applied output potential.

5.11.6 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the connection shall be open-circuited at the point of attachment to the accessible part.

5.12 Resistance to moisture

5.12.1 Water spray

5.12.1.1 An outdoor use appliance that is not marked as specified in item 3, 5, or 11 of [Table 18](#) shall be tested as described in Clauses [5.12.1.2](#) and [5.12.1.3](#):

a) During and after the test:

- 1) There shall be no wetting of any electrical component; and
- 2) No water shall enter a compartment housing field-installed wiring; and

b) After the test:

- 1) A cord-connected appliance shall comply with the requirements in Clause [5.3.1](#), leakage current test, except that the test shall be discontinued when the leakage current stabilizes; and
- 2) An appliance shall comply with the requirement in Clause [5.11.1](#), dielectric voltage-withstand test.

5.12.1.2 To determine whether a vacuum cleaner complies with the requirements in Clauses [4.2.3.5](#) and [5.12.1.1](#), the appliance shall be mounted under the apparatus described in Clause [5.12.1.3](#) and subjected to a water spray for 1 h while operating and 1 h while not operating.

5.12.1.3 The water spray apparatus shall consist of three spray heads constructed in accordance with the details illustrated in [Figure 7](#) and mounted in a water supply pipe rack as illustrated in [Figure 8](#). The water pressure shall be maintained at each spray head at approximately 34 kPa (5 lbf/in²). The distance between the center nozzle and the appliance shall be approximately 1.5 m (5 ft). The appliance shall be brought into the focal area of the three spray heads in such a position and under such conditions that water will be most likely to enter, except that consideration shall be given to the normal mounting position.

5.12.2 Wet pick-up

5.12.2.1 A wet pick-up appliance shall be conditioned as described in Clauses [5.12.2.3](#) and [5.12.2.4](#). After the conditioning:

- a) There shall be no obvious wetting of any uninsulated live part (see Clause [5.12.2.2](#));
- b) No water shall enter a compartment housing field-installed wiring;
- c) The appliance:

1) If grounded:

- i) After the conditioning, shall comply with the dielectric voltage-withstand requirement in Clause [5.11](#);
- ii) If cord connected, during and after the conditioning, shall not have a leakage current of more than 5.0 MIU when tested as described in Clauses [5.3.3](#) – [5.3.7](#);

2) If double insulated, shall comply with the leakage current and dielectric voltage withstand requirements specified in Clauses [6.12.1](#) and [6.19](#).

5.12.2.2 Obvious wetting as mentioned in Clauses [5.12.2.1\(a\)](#) and [5.12.8.1.1](#) signifies wetting by a stream, spray, or dripping of water or fluid on the component that obviously will be repeated during each test, but does not signify wetting by random drops of water or fluid that may wet the component by chance.

5.12.2.3 A wet pick-up appliance shall be operated while picking-up water as noted in (a), (b) or (c). The hose end shall be immersed in the water. A float, if provided, shall be defeated:

- a) An appliance that discharges water into a compartment that contains electrical components, including the motor windings, shall be operated for 5 min after it begins to discharge water;
- b) An appliance other than as noted in (a) and that is provided with a float shall be operated until it has picked up as much water as its capacity permits as evidenced by water discharge from the exhaust (or other) opening; or
- c) An appliance other than as noted in (a) and that is not provided with a float shall be operated for 5 min after it begins to discharge water. The temperature of the motor winding shall not exceed 140°C (284°F) for Class A motors, 165°C (329°F) for Class B motors, or 190°C (374°F) for Class F motors.

5.12.2.4 A wet pick-up appliance employing double insulation shall be subjected to the two additional wet pick-up test conditions described in (a) and (b).

- a) The appliance shall be operated as described in Clause [5.12.2.3](#), except that a float shall not be defeated and the water shall include a low-sudsing detergent in the amount of 5 g/L. This solution shall be picked up in a manner to promote sudsing. The test shall also be terminated if the float operates to seal the vacuum air inlet such that water cannot discharge from the exhaust opening.
- b) A float shall be defeated. The appliance shall be operated picking up water from a level above the top of the appliance until it has picked up its maximum capacity. The appliance shall then be de-energized (not disconnected) and the water allowed to continue to siphon for a period of 5 s following first evidence of water discharge through the exhaust (or other) opening. The appliance shall then be reenergized while simultaneously lifting the pick-up hose up out of the water. Operation shall be continued until water ceases to discharge through the exhaust opening.

5.12.2.5 When a motorized nozzle intended for wet pick-up use with an extraction-type carpet cleaning system or an upright-type wet pick-up appliance with a driven brush is operated under each of the conditions described in Clause [5.12.2.6](#) or [5.12.2.7](#), respectively:

- a) There shall not be obvious wetting of any uninsulated live part or film-coated wiring; and
- b) The appliance:

1) Shall not have a leakage current of more than 0.5 MIU when tested as described in Clauses [5.3.3](#) – [5.3.7](#) during and immediately after operation; and

- 2) Shall comply with the dielectric voltage-withstand requirements in Clause [5.11](#) after operation.

5.12.2.6 A motorized nozzle of the type specified in Clause [5.12.2.5](#) shall be operated in a flat-bottomed vessel filled with water so that a depth of 3.2 mm (1/8 in) of water is maintained. The vessel shall be a size such that the nozzle moves about freely; and the motorized nozzle shall be operated:

- a) Without a vacuum cleaner attached for 15 min; and
- b) With a vacuum cleaner attached until the appliance has picked up as much water as its capacity holds or for 5 min, whichever occurs sooner.

5.12.2.7 An appliance of the type specified in Clause [5.12.2.5](#) shall be operated in a flat-bottomed vessel filled with water so that a depth of 3.2 mm (1/8 in) of water is maintained. The vessel shall be of a size such that the appliance moves about freely, and:

- a) For an appliance with the provision for the operation of a driven brush without operation of the vacuum motor:
 - 1) The driven brush shall be operated for 15 min; and
 - 2) The complete appliance shall be operated until it has picked up as much water as its capacity holds or for 5 min, whichever occurs sooner; and
- b) For an appliance other than as noted in (a), the complete appliance shall be operated for 20 min. The water level shall be maintained at the 3.2-mm (1/8-in) level. When the liquid container is filled to capacity, operation shall be halted and the container emptied. The time needed for emptying shall not be included in the 20 min of appliance operation.

5.12.3 Cord reel wetting

5.12.3.1 An appliance, such as a wet pick-up vacuum cleaner, that employs a cord reel shall be conditioned as described in Clause [5.12.3.2](#). The appliance shall comply with Clause [5.12.2.1](#) (a) and (c).

5.12.3.2 A solution consisting of low-sudsing detergent and room temperature water in the amount of 5 g/L shall be placed in a shallow container to a depth of 12.7 mm (1/2 in) minimum. The power supply cord of the appliance shall be fully extended, and the entire length of cord that can contact the floor shall be placed in the container. The cord shall be oriented such that it does not interfere with the normal retraction process. The cord shall then be retracted back into the cord reel housing as intended. This procedure shall be repeated four times for a total of five complete tests. The attachment plug cap (including the blades) shall be dried with a soft cloth to remove any surface moisture before conducting the leakage current and dielectric voltage-withstand tests.

5.12.4 Overflow

5.12.4.1 An appliance that employs a liquid reservoir intended to be filled by the user shall be conditioned as described in Clause [5.12.4.2](#). During and after conditioning, the appliance shall comply with Clause [5.12.2.1](#). The test shall be conducted with the control switch in the on position and switch S1 from [Figure 6](#) open.

Exception: A product having a reservoir that must be removed to be filled need not comply with this requirement.

5.12.4.2 The product and reservoir shall be in their intended position for filling of the reservoir. Distilled water with 0.6 g/L of sodium chloride and 5.4 g/L of a low sudsing detergent shall be poured into the liquid

reservoir through an orifice 3 per 9.5-mm (8-inches) in diameter until the reservoir is filled to maximum capacity. Additional solution equal to 15% of the capacity, but not more than 0.47 L (1 pint), shall then be poured into the reservoir.

5.12.5 Flooding of live parts

5.12.5.1 The malfunction of a timer switch, a float, or a pressure-operated switch, or the deterioration or damage of a part of rubber or similar material, such as a boot, diaphragm, seal, or gasket, shall not cause flooding of the electrical components of an appliance that employs water or other electrically conductive liquid in its operation.

5.12.5.2 To determine whether an appliance complies with the requirement in Clause [5.12.5.1](#) with respect to the deterioration or damage of a part, such as a boot, diaphragm, seal, or gasket, such a part shall be removed completely and the machine operated as in normal operation.

Exception: A part, such as a boot, diaphragm, seal, or gasket, not subject to flexing and also for use with water or a proprietary fluid as described in Clause [2.2.1](#), is not required to be removed if the part complies with Clause [5.12.5.4](#).

5.12.5.3 With reference to Clauses [5.12.5.1](#) and [5.12.5.2](#), infrequent motion of small amplitude, such as that experienced during normal operation by a diaphragm covering a pressure-sensitive switch, shall not be considered to constitute flexing.

5.12.5.4 To determine compliance with the Exception to Clause [5.12.5.2](#), three samples of a part, such as a boot, diaphragm, seal, or gasket, shall be subjected to each applicable condition as described in [Table 20](#). After the conditioning, the material used shall retain 50% of its original tensile strength and elongation. The tensile strength and elongation test shall be conducted in accordance with UL 157.

Exception No. 1: If the part is subjected to water only in its operation, the part need not comply with the immersion conditioning.

Exception No. 2: If a part (such as a boot, diaphragm, seal, or gasket) is too small to determine the percent elongation and tensile strength, the part shall be subjected to a visual examination. The part shall not harden, deform, melt, or otherwise deteriorate to a degree that will adversely affect the sealing properties.

5.12.6 Tipover

5.12.6.1 A wet pick-up vacuum cleaner employing double insulation shall be subjected to the tests described in Clauses [5.12.6.4](#), [5.12.6.5](#), and [5.12.6.6](#). As a result of the tests:

- a) There shall not be obvious wetting of any uninsulated live parts (see Clause [5.12.2.2](#));
- b) The leakage current shall not exceed 5.0 MIU during and after the conditioning when the appliance is tested as specified in leakage current, Clause [5.3](#); and
- c) The appliance shall comply with the dielectric voltage-withstand, as described in Clause [6.19.1\(b\)](#).

5.12.6.2 A wet pick-up appliance that is provided with grounding and that is supported by the body of a person and not solely hand held shall be subjected to the tests in Clauses [5.12.6.4](#), [5.12.6.5](#), and [5.12.6.6](#). As a result of the tests:

- a) There shall not be obvious wetting of any uninsulated live parts (See Clause [5.12.2.2](#));

- b) The leakage current shall not exceed 5.0 MIU during and after the conditioning when the appliance is tested as specified in leakage current, Clause [5.3](#); and
- c) The appliance shall comply with the dielectric voltage-withstand test, Clause [5.11](#), between live parts and accessible noncurrent-carrying metal.

5.12.6.3 A wet pick-up appliance that is provided with grounding and that is completely supported in the hand shall be subjected to the tests described in Clause [5.12.6.5](#). As a result of the tests:

- a) There shall not be obvious wetting of any uninsulated live parts (See Clause [5.12.2.2](#));
- b) The leakage-current shall not exceed 5.0 MIU during and after the conditioning when the appliance is tested as specified in leakage current, Clause [5.3](#); and
- c) The appliance shall comply with the dielectric voltage-withstand test, Clause [5.11](#), between live parts and accessible noncurrent-carrying metal.

5.12.6.4 A float shall be defeated. The appliance shall be operated continuously picking up water until the container is filled to maximum capacity. The appliance shall then be de-energized (not disconnected) and tipped over for 30 s. The tipover shall consist of placing the appliance to rest on its side (approximately 90°). It shall then be returned to its upright position and energized for 30 s drawing in air only. This procedure of filling to capacity, tipping over, and uprighting shall be repeated for a total of four times, tipping in a different direction each time.

5.12.6.5 The test described in Clause [5.12.6.4](#) shall be repeated (four tips) but with the following changes:

- a) The appliance shall be allowed to continue to operate (remain energized) when tipped over, with the hose removed from the water supply; and
- b) The cleaner shall be tipped for a period of 5 s.

5.12.6.6 A backpack-type body supported appliance shall be subjected to two additional tipover conditions. The tests described in Clauses [5.12.6.4](#) and [5.12.6.5](#) (not operating and operating) shall be repeated with the sample being tipped 180°.

5.12.6.7 A new appliance may be used for each of the tipovers described in Clauses [5.12.6.4](#), [5.12.6.5](#), and [5.12.6.6](#). If the same appliance is used for all conditions, disassembly for the examination for wetting of live parts, as mentioned in Clause [5.12.2.1\(a\)](#) need only be made following the final tipover.

5.12.7 Wet scrubbing

5.12.7.1 After the test specified in Clause [5.12.7.2](#), a household floor finishing machine shall comply with (a) – (c):

- a) There shall be no obvious wetting of any uninsulated live part (see Clause [5.12.2.2](#));
- b) No water shall enter a compartment housing field-installed wiring;
- c) The machine:
 - 1) If grounded:
 - i) After the conditioning, shall comply with the dielectric voltage-withstand test, Clause [5.11](#);

ii) During and after the conditioning, shall not have a leakage current of more than 0.5 MIU when tested as described in Clauses [5.3.3](#) to [5.3.7](#); and

2) If double insulated, shall comply with the leakage current test, Clause [6.12](#), and dielectric voltage-withstand test, Clause [6.19](#) (b).

5.12.7.2 A household use floor finishing machine intended for floor scrubbing shall be operated for 15 min in a flat-bottomed container filled with water to a depth of 3.2 mm (1/8 in). The container shall be sufficiently large so that the product can move freely.

5.12.8 Polymeric fluid-handling components

5.12.8.1 General

5.12.8.1.1 An appliance that employs a polymeric fluid-handling component (PFHC), such as a reservoir, tank, or tubing, shall be subjected to the test described in Clause [5.12.8.1.2](#). The test shall be conducted with the appliance unenergized and connected to the supply circuit, and then energized and operated under normal load conditions. Separate samples may be used for the unenergized and energized normal load conditions. See [Figure F.1](#). As a result of the test:

a) There shall be no obvious wetting of live parts, film-coated wire, or insulation adversely affected by the fluids used with the appliance. Obvious wetting signifies wetting by a stream, spray, or dripping of water or fluid that obviously will be repeated during each test, but does not signify wetting by random drops of water or fluid that may be wetted by chance;

b) No water shall enter a compartment housing field-installed wiring; and

c) The appliance:

1) If grounded:

i) If cord connected, during and after the conditioning, shall not have a leakage current of more than 5.0 MIU when tested as described in Clauses [5.3.3](#) – [5.3.8](#), except that the test shall be discontinued when the leakage current stabilizes or for a minimum of five minutes after the conditioning.

ii) After the conditioning, shall comply with the dielectric voltage-withstand requirement in Clause [5.11](#); or

2) If double insulated:

i) If cord connected, during and after the conditioning, shall comply with the leakage current test specified in Clause [6.19](#) (applying Clauses [6.12.1](#), [6.12.2](#), and [6.12.4](#)), except that the test shall be discontinued when the leakage current stabilizes or for a minimum of five minutes after the conditioning.

ii) After the conditioning, shall comply with the dielectric voltage withstand requirements specified in Clause [6.19](#).

5.12.8.1.2 To determine if an appliance using a PFHC complies with Clause [5.12.8.1.1](#), a 6.4-mm (1/4-in) diameter hole shall be drilled in the PFHC in any location that can result in the solution reaching a live part, film-coated wire, or insulation. The hole shall then be plugged and the reservoir shall be filled to 50 ±5% of its capacity with the solution described in Clause [5.12.4.2](#). The plug shall then be removed so that all of the solution flows out. The component shall be in its intended position and the appliance shall be in the position that during intended use allows maximum exposure to the solution. For a component, such as tubing, attached to the output of a pump and the pump itself, the pump shall be operated until the reservoir

is empty. For machines that are provided with instructions to use other than proprietary fluids, Exception 2 does not apply.

Exception No. 1: If the inside diameter of the tubing is less than 6.4 mm (1/4 in), the size of the hole drilled in the tubing shall be equal to the inside diameter of the tubing.

Exception No. 2: For a household extraction-type floor cleaning machine, a PFHC intended for use only with water, that complies with Clause [5.12.8.2](#), is considered to meet this requirement.

Exception No. 3: For a household extraction-type floor cleaning machine, a PFHC intended to be used with a proprietary fluid that complies with Clauses [5.12.8.2](#) and [5.12.8.3](#) is considered to meet this requirement. See also Clauses [2.2](#), [12.2.7\(i\)](#), and [Table 18](#), Item 16.

5.12.8.1.3 In the application of Clause [5.12.8.1.2](#) for a PFHC used in the fluid recovery system that does not come in contact with the fluid until the recovery operation, the test shall be conducted as follows: the reservoir shall be filled to 50% of its capacity with the test solution. The sample shall then be operated on a hard surface spraying down the test solution and picking it up until the half tank of solution is used, taking care to ensure the maximum amount of fluid put down is picked back up through the recovery system. For the recovery tank, following this operation, the unit shall be de-energized and the entire content recovered in the tank shall be permitted to flow.

5.12.8.2 PFHC used in household extraction-type floor cleaning machines – Mold stress and impact testing

5.12.8.2.1 With reference to Exception No. 2 and 3 of Clause [5.12.8.1.2](#), if deterioration, breakage, or the like of a PFHC can result in the risk of fire or electric shock, samples of the PFHC shall be subjected to the following tests. As a result of these tests, there shall be no leakage such that the appliance does not comply with the requirements of Clause [5.12.8.1.1](#).

- a) One sample shall be subjected to the mold stress-relief distortion test as described in Clause [5.21.3](#); and
- b) One sample shall be subjected to an impact test as described in Clause [5.19.2](#) or [5.19.3](#), as follows:
 - 1) For a floor-supported appliance, the impact test shall be as described in Clause [5.19.3](#) if the PFHC location can be exposed to a blow in normal use. Reservoirs or tanks shall be subjected to the ball impact test while empty and in normal use position; or
 - 2) For other than floor-supported appliances, the impact test shall be as described in Clause [5.19.2](#) with the component in its intended position.

5.12.8.2.2 In determining compliance with the requirements specified in Clause [5.12.8.1.1](#), the PFHC shall be placed in its intended position. The appliance shall then be placed in the position that, during intended use, allows maximum exposure to the fluid. The reservoir or tank shall be filled to its capacity with the solution described in Clause [5.12.4.2](#), and a pump, if provided, shall be operated until the reservoir or tank is empty. If after the conditioning, the test sample is deformed and cannot be properly placed in its intended position within the appliance, the conditioned PFHC may be placed in a simulated appliance test sample that provides equivalent exposure to the fluid.

Exception: After the mold stress and impact tests, the evaluation of Clause [5.12.8.2.2](#) is not required and the leakage current and dielectric tests are not required if there is no water leakage from the PFHC. To determine compliance with this exception, the PFHC shall be filled with water to its maximum capacity for a period of five minutes, and any water leakage determined by observation.

5.12.8.3 PFHC used in household extraction-type floor cleaning machines for use with proprietary fluids – PFHC conditioning

5.12.8.3.1 Reservoir, tank, tubing, and similar

5.12.8.3.1.1 With reference to Exception No. 3 to Clause [5.12.8.1.2](#), if deterioration, breakage, or the like of a PFHC intended for use with a proprietary fluid can result in the risk of fire or electric shock, samples of the PFHC shall be subjected to the conditioning described below. As a result of the conditioning and tests, the appliance shall comply with the requirements of Clause [5.12.8.1.1](#)(a) and (c).

5.12.8.3.1.2 Three samples of the PFHC shall be subjected to the test specified in Clause [5.12.8.3.1.3](#). The test fluid shall be a solution consisting of three times the recommended concentration of the proprietary fluid. The test fluid shall be heated to a temperature of 10°C (18°F) above the temperature to which the PFHC is subjected during normal operation, but not less than 70°C (158°F). If more than one fluid is recommended, the fluids with the highest pH, lowest pH, highest d-limonene, and highest organic solvent (including d-limonene) available for a given machine shall be employed.

Exception No. 1: 100% concentration of the proprietary fluid or fluids shall be used for the solution for an appliance that has a polymeric fluid-handling component, such as a reservoir assembly, that contains only the proprietary fluid.

Exception No. 2: A part such as a boot, diaphragm, seal, or gasket need not comply, but shall comply with Clause [5.12.5.2](#).

Exception No. 3: If more than one fluid is recommended, a single pH solution may be employed if the fluids with the highest and lowest pH are between 6 and 8.5 (representing the normal pH in ground water). For example, testing only the highest d-limonene content solution meets the intent of this requirement if all the recommended fluids exhibit pH's between 6 and 8.5 and do not contain higher organic solvent content. Similarly, testing only the highest organic solvent content (including d-limonene) solution meets the intent of this requirement if all of the recommended fluids exhibit pH's between 6 and 8.5.

5.12.8.3.1.3 The heated test fluid shall be pumped through the PFHC using a cycle time of ON (fluid flowing) for 8 min and OFF (no fluid flowing) for 2 min for 7 days. The test pressure shall be the pressure the PFHC is subjected to during normal operation. The PFHC may be tested in its intended position separate from the appliance. The test shall be conducted to allow maximum exposure of the test fluid to the PFHC surfaces that are in contact with the proprietary fluid in normal use (e.g., the interior surfaces of tanks or tubing).

Exception No. 1: If a pump is used for the above conditioning, and the pump ceases to operate before the completion of the 7 days, the conditioning may be continued by replacing the pump, or by continuing the conditioning using the method in Exception No. 2 until the remaining time of the 7-day conditioning is complete.

Exception No. 2: As an alternate to the cycled conditioning, the PFHC shall be filled to its maximum capacity (or to its fill line, if provided) with the heated test fluid for a period of 7 days. The temperature of the test fluid shall be maintained at the test temperature for the entire 7-day period.

Exception No. 3: As an alternate to the cycled conditioning, three samples of the PFHC shall be immersed in a boiling solution consisting of three times the recommended concentration of the proprietary fluid for seven days. The test equipment shall be capable of maintaining the solution at the required concentration for the entire seven days of boiling conditioning. If more than one fluid is recommended, the fluids with the highest pH, lowest pH, highest d-limonene, and highest organic solvent (including d-limonene) available for a given machine shall be employed; see the Exceptions to Clause [5.12.8.3.1.2](#).

Exception No. 4: As an alternate to the cycled conditioning, three samples of the PFHC shall be immersed in a solution consisting of three times the recommended concentration of the proprietary fluid for 1000 h at a temperature of 10°C (18°F) above the temperature to which the component is subjected, but not less than 70°C (158°F). If more than one fluid is recommended, the fluids with the highest pH, lowest pH, highest d-limonene, and highest organic solvent (including d-limonene) available for a given machine shall be employed; see the Exceptions to Clause [5.12.8.3.1.2](#).

5.12.8.3.1.4 In determining compliance with the requirements specified in Clause [5.12.8.1.1](#), after the conditioning the PFHC shall be placed in its intended position. The appliance shall then be placed in the position that, during intended use, allows maximum exposure to the fluid. The reservoir or tank shall be filled to its capacity with the solution described in Clause [5.12.4.2](#), and a pump, if provided, shall be operated until the reservoir or tank is empty. If after the conditioning, the test sample is deformed and cannot be properly placed in its intended position within the appliance, the conditioned PFHC may be placed in a simulated appliance test sample that provides equivalent exposure to the fluid.

Exception: After the conditioning, the evaluation of Clause [5.12.8.3.1.4](#) is not required and the leakage current and dielectric tests are not required if there is no water leakage from the PFHC. To determine compliance with this exception, the PFHC shall be filled with water to its maximum capacity (or to its fill line, if provided) for a period of five minutes, and any water leakage determined by observation.

5.12.8.3.2 Pumps used in household extraction-type floor cleaning machines for use with proprietary fluids – Conditioning and testing

5.12.8.3.2.1 A pump of a household extraction-type floor cleaning machine that is intended to be used with a proprietary fluid and that employs polymeric fluid-handling parts shall be conditioned as described in Clause [5.12.8.3.2.2](#). If more than one fluid is recommended, the fluids with the highest pH, lowest pH, highest d-limonene, and highest organic solvent (including d-limonene) available for a given machine shall be employed for the pump conditioning described in Clause [5.12.8.3.2.2](#). After the conditioning, the appliance shall comply with the requirements in Clause [5.12.8.1.1](#).

Exception No. 1: 100% concentration of the proprietary fluid or fluids shall be used for the solution for an appliance that has a polymeric fluid-handling component, such as a reservoir assembly, that contains only the proprietary fluid.

Exception No. 2: If more than one fluid is recommended, a single pH solution may be employed if the fluids with the highest and lowest pH are between 6 and 8.5 (representing the normal pH in ground water). For example, testing only the highest d-limonene content solution meets the intent of this requirement if all the recommended fluids exhibit pH's between 6 and 8.5 and do not contain higher organic solvent content. Similarly, testing only the highest organic solvent content (including d-limonene) solution meets the intent of this requirement if all of the recommended fluids exhibit pH's between 6 and 8.5.

5.12.8.3.2.2 The pump shall be continuously cycled ON for 8 min and OFF for 2 min for 7 days while pumping a solution consisting of three times the recommended concentration of the proprietary fluid. The test fluid shall be heated to a temperature of 10°C (18°F) above the temperature to which the PFHC is subjected during normal operation, but not less than 70°C (158°F). The pump may be tested in its intended position separate from the appliance.

5.12.8.3.2.3 For a pump employing a motor with brushes, if the pump ceases to operate in 25 h or less due to brushes wearing out, the brushes shall be replaced. If the pump ceases to operate after 25 h, but before the completion of the 7 days, the conditioning shall be considered complete.

5.12.8.3.2.4 In determining compliance with the requirements specified in Clause [5.12.8.1.1](#), after the conditioning and testing, the pump shall be placed in its intended position and the appliance shall be in the position that, during intended use, allows maximum exposure to the fluid. The reservoir or tank shall be

filled to its capacity with the solution described in Clause [5.12.4.2](#), and the pump shall be operated until the reservoir or tank is empty. If the pump is not operable after 25 h, then the appliance shall be operated for the period of time normally needed for the pump to empty the reservoir or tank.

5.12.8.4 Tubing pressure test

5.12.8.4.1 Tubing described in Clause [4.3.1.4](#) shall be subjected to a hydrostatic pressure of two times the maximum pressure for a period of one minute after the conditioning described in Clause [5.12.8.4.2](#). As a result of the test there shall be no leaking.

Exception: If there is leaking from the tubing, the tubing sample shall be installed in the appliance. The appliance shall then be placed in the position that, during intended use, allows maximum exposure to the fluid. The reservoir or tank shall be filled to its capacity with the solution described in Clause [5.12.4.2](#), and a pump, if provided, shall be operated until the reservoir or tank is empty. The appliance shall then comply with Clause [5.12.8.1.1](#)(a) and (c).

5.12.8.4.2 Prior to the hydrostatic pressure testing, the samples shall be conditioned as follows:

- a) Two samples as received;
- b) Two samples after mold stress-relief distortion, see Clause [5.21.3](#); and
- c) For tubing for use only with a proprietary fluid, two samples after the cycled conditioning as described in Clause [5.12.8.3.1.2](#).

5.12.8.4.3 As an alternative to the tubing pressure test of Clause [5.12.8.4.1](#), the following test method may be used: the sample shall be connected to a 120 V, 60 Hz source of supply with the Switch S1 of the leakage current measurement circuit in the "open" position. The machine control switches shall be placed in the "on" position. The tube shall be disconnected from the connection and the reservoir filled to 50% of its capacity with the solution described in Clause [5.12.4.2](#). The tubing shall be directed in various positions to achieve worse-case scenarios. During this test, the reservoir shall be in its normal position on the machine and in the position which allows maximum exposure of live parts to the fluid. The sample shall be energized and the pump shall be operated until the reservoir is empty for each location under test. During this test, and for a minimum of 5 min thereafter, the leakage current shall be monitored. Following the test the sample shall be subjected to a repeat of the Dielectric Withstand Test. As a result of the test, the sample shall comply with Clause [5.12.8.1.1](#).

5.12.9 Cleaning test

5.12.9.1 The cleaning of an electrical attachment provided with contacts located on the underside of the attachment shall not result in a risk of electric shock, when tested in accordance with Clauses [5.12.9.2](#) through [5.12.9.5](#).

5.12.9.2 A sample of the electrical attachment shall be subjected to three simulated cleanings in accordance with the manufacturer's instructions. If instructions are not provided, then the sample shall be subjected to three simulated cleanings of the underside of the attachment in the area of the electrical contacts using a damp cloth (a cloth that is completely wet but not dripping). Each cleaning shall consist of 10 back-and-forth movements in 10 s.

5.12.9.3 The sample shall be orientated in the position considered worse case (e.g. with the underside of the attachment facing upwards), while attached to the appliance as intended. During each of the three simulated cleanings, the leakage current shall be measured in accordance with the applicable leakage current test (see Clause [5.3](#) or [6.12](#)) with the appliance connected to the power supply but not energized. The leakage current shall be measured between metal foil with an area of 10 × 20 cm (3.9 × 7.9 inch) in

contact with the thermoplastic surfaces nearest the electrical contacts of the sample and the grounded side of the supply source.

5.12.9.4 Immediately after the three simulated cleanings, the sample shall be orientated as in normal use, and the leakage current shall again be measured in accordance with the applicable leakage current test (see Clause [5.3](#) or [6.12](#)) between metal foil with an area of 10 × 20 cm (3.9 × 7.9 inch) in contact with the thermoplastic surfaces nearest the electrical contacts of the sample and the grounded side of the supply source, and then subjected to the applicable dielectric withstand test (see Clause [5.11](#) or [6.19](#)).

5.12.9.5 The sample shall then be disassembled and examined for the presence of water on electrical components. There shall be no obvious wetting of any uninsulated live part (see Clause [5.12.2.2](#)).

5.13 Stability

5.13.1 An appliance as mentioned in Clause [4.20.5.1](#) shall be subjected to the stability test. The appliance shall not be energized during the stability test, and shall be filled with water to maximum normal capacity. The test shall be conducted under conditions most likely to cause the appliance to overturn. The following conditions shall be such as to result in the least stability:

- a) The position of all casters and other movable or adjustable parts, including that of the supply cord resting on the surface supporting the appliance;
- b) The connection of or omission of any attachment made available or recommended by the manufacturer; and
- c) The direction in which the appliance is tipped or the supporting surface is inclined.

5.13.2 The appliance shall be separately tested under both of the following conditions:

- a) The appliance shall be positioned at an angle of 10° from the horizontal by:
 - 1) Placement on an inclined plane; or
 - 2) Tipping from an at-rest position on a horizontal plane; and
- b) The appliance shall be subjected to a 22-N (5-lb) pulling force applied at the hose connection point and parallel to the supporting surface, with the appliance on a horizontal surface and the wheels blocked.

5.13.3 A vacuum cleaner with a steam-cleaning attachment in which liquid is heated to a temperature greater than 115°F (46°C), shall be tested in accordance with Clauses [5.13.1](#) and [5.13.2](#), except the steam cleaner part of the vacuum cleaner shall be placed on a plane inclined at an angle of 15° to the horizontal.

5.14 Strain relief

5.14.1 When tested as described in Clause [5.14.2](#), the strain-relief means provided on the power-supply cord shall withstand for 1 min, without displacement, a force of 156 N (35 lbs) applied to the cord, with the connections within the appliance disconnected. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections.

5.14.2 A 15.9-kg (35-lb) weight shall be suspended from the cord and supported by the appliance so that the strain-relief means will be stressed from any angle that the construction of the appliance permits.

5.14.3 For the investigation mentioned in the Exception to Clause [4.5.3.2](#), four samples of the clamp that have been applied to the cord in the intended manner shall be used. One sample shall be subjected to the dielectric voltage-withstand and strain-relief tests in the as-received condition. The other three samples shall be placed in an air oven for 168 h. The oven temperature shall be 10°C (18°F) higher than the maximum temperature measured on the cord at the strain-relief device under normal operating conditions, but not less than 70°C (158°F) in any case. The samples, after being conditioned in the oven, shall be subjected to the dielectric voltage-withstand and strain-relief tests. The value of the applied potential shall be as indicated in Clause [5.11](#). The potential shall be applied between the conductors and, if the clamp is metal, the potential shall be applied between the conductors and the clamp. After cooling to room temperature, the conditioned samples shall comply with the strain-relief test requirements in Clause [5.14.1](#) and the dielectric voltage-withstand requirements in Clause [5.11](#).

5.15 Switches, relays, and similar controls

5.15.1 A switch or other device that controls a motor of an appliance, unless it has been found to be acceptable for the application or is interlocked so that it will never break the locked-rotor motor current, shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the appliance. There shall be no electrical or mechanical breakdown of the device or undue pitting or burning of the contacts, and the fuse in the grounding connection shall not open.

5.15.2 To determine whether a switch or other control device complies with the requirement in Clause [5.15.1](#), the appliance shall be connected to a grounded supply circuit. The rotor of the motor shall be locked in position. During the test, exposed noncurrent-carrying metal parts shall be connected to ground through a 3-A plug fuse, and the connection shall be such that any single-pole, current-rupturing device will be located 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 alternating current, the exposed noncurrent-carrying metal parts of the appliance shall be connected so as to be positive with respect to a single-pole, current-rupturing control device. The device shall be operated at a rate not more than 10 cycles per minute, except that a faster rate of operation may be employed, if agreeable to those concerned.

5.15.3 The flexible thermoplastic switch actuator of a membrane-type switch shall withstand a 6000 cycle mechanical endurance test as specified in Clause [5.15.4](#). At the completion of the test there shall be no electrical or mechanical failure of the flexible switch actuator.

5.15.4 A sample of the switch actuator shall be subjected to 6000 cycles of mechanical actuation, without voltage applied to the appliance, at a minimum cycle rate of 6 cycles per minute.

5.15.5 An operating control using a power-switching semiconductor shall be subjected to the overload test specified in Clause [5.15.1](#). The control shall be additionally subjected to the 6,000-cycle endurance test specified in Clause [5.15.6](#). As a result of the endurance test, there shall not be electrical or mechanical malfunction of a power-switching semiconductor nor opening of the fuse connected to dead metal parts.

5.15.6 To determine compliance with Clause [5.15.5](#), the appliance shall be connected to a grounded power-supply circuit of rated frequency and voltage. During the test, exposed dead metal parts of the appliance shall be connected to earth ground through a 3-A non-time-delay plug fuse, and the connection shall be such that any single-pole current interrupting device is in the ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, exposed dead metal parts of the appliance shall be so connected as to be positive with respect to a single-pole, current interrupting device. The device shall be operated at a rate of 6 – 10 cycles per minute, with an "on" time of one second.

5.15.7 For the tests specified in Clauses [5.15.5](#) and [5.15.6](#), the control shall be mounted in the end-use product as intended. Each cycle shall consist of starting with the semiconductor in the standby condition, initiation of the activation circuit, and restoration of the device to the standby condition.

5.16 Cord reel flexing

5.16.1 The supply cord on a cord reel shall withstand a 6000 cycle mechanical endurance test as specified in Clauses [5.16.2](#) and [5.16.3](#) (without voltage applied) as follows:

- a) At the completion of the test there shall be no undue abrasion of or other damage to the cord jacket, breakage of the conductors, or evidence of undue wear of the movable and stationary contacts; and
- b) After completion of the test the appliance shall still function and shall withstand the specified dielectric voltage-withstand test.

5.16.2 The supply cord shall be unreeled for a length of not less than 762 mm (30 in), and recoiled on the reel by the automatic re-reeling action at a rate not exceeding 10 cycles per min, unless the manufacturer agrees to a faster rate.

5.16.3 The supply cord shall be unreeled in such a direction that the greatest abrasion to the jacket occurs, and to result in as close to a 90° bend in the cord as practical at the exit from the appliance enclosure.

5.17 Power-supply cord flexing

5.17.1 The power-supply cord of a portable appliance shall be subjected to the test specified in Clauses [5.17.3](#) – [5.17.7](#). As a result of the test, there shall not be:

- a) Short circuit between the conductors (see Clause [5.17.2](#));
- b) Breakage of more than 10% of the strands of any conductor;
- c) Movement of the cord in its strain relief that indicates that stress has resulted on the cord connections;
- d) Loosening of any cord guard;
- e) Damage to the cord or cord guard which impairs compliance with this Standard; or
- f) Broken strands piercing the insulation and becoming accessible.

Exception: This test does not apply to appliances with cord reels. Such appliances are tested in accordance with Clause [5.16](#).

5.17.2 With reference to Clause [5.17.1](#), conductors include grounding conductors. A short circuit between conductors of the cord is determined when, any time during the test, the current exceeds a value equal to twice the rated current of the appliance.

5.17.3 The part of the appliance comprising the cord entry, the cord guard, when supplied, and the supply cord shall be fixed to an apparatus having an oscillating member as shown in [Figure 24](#), so that, when the oscillating member is at the middle of its travel, the axis of the cord where it enters the cord guard or cord entry is vertical and passes through the axis of oscillation. The distance A, as shown in [Figure 24](#), between the axis of oscillation and the point where the cord or cord guard enters the appliance shall be adjusted so that when the oscillating member moves over its full range, the cord and load make

the minimum lateral movement. For this test, the cord entry is the last point at which the cord is permanently attached to the appliance by the manufacturer and which is most likely to flex during use.

5.17.4 The load shown in [Figure 24](#) shall be 10 N (2.25 lbf).

5.17.5 The oscillating member shall be moved through an angle of 90° (45° on either side of the vertical), at a rate of 60 flexings per minute. A flexing is one movement of 90°. The number of flexings shall be:

- a) For household use – 10,000 flexings if the cord can be replaced without damaging the appliance; otherwise 20,000 flexings;
- b) For commercial use – 20,000 flexings.

5.17.6 The cord and its associated parts shall be turned through an angle of 90° after half the number of flexings.

5.17.7 During the test, the conductors shall be loaded to the rated current of the appliance. The rated voltage shall be applied between the conductors. Current shall not be passed through the grounding conductor which shall be connected to ground.

5.18 Internal wiring and interconnecting cord flexing

5.18.1 With reference to Clause [4.7.5.5](#), after being subjected to the test specified in Clause [5.18.2](#), an upright-type vacuum cleaner or motorized nozzle shall:

- a) Operate as intended;
- b) Not have damaged wire insulation that exposes bare conductor;
- c) Comply with Clause [5.11](#), dielectric voltage-withstand, with the wiring under test wrapped in metal foil; and
- d) Not exceed the temperature limit specified in [Table 9](#) for the wiring under test when subjected to a repeat temperature test in accordance with temperature, Clause [5.8](#).

Exception: Breakage of no more than 10% of the strands of any conductor of the wiring routed between the handle and the base of an upright-type vacuum cleaner shall be considered to comply with item (d).

5.18.2 A cycle of flexing shall start with the handle in the vertical (stored) position. The handle shall be rotated until the center of the handle grip area is in the position described in (a) or (b), and then returned to the vertical position. The appliance shall remain energized during the test. The number of cycles shall be as specified in Clause [5.18.3](#):

- a) The handle shall be rotated to 78.7 cm (31 in) from the floor; or
- b) The handle shall be rotated to its maximum extent.

5.18.3 Household appliances shall be subjected to 9000 cycles of flexing to the position specified in Clause [5.18.2\(a\)](#) followed by 1000 cycles of flexing to the position specified in Clause [5.18.2\(b\)](#). Commercial appliances shall be subjected to 45,000 cycles of flexing to the position specified in Clause [5.18.2\(a\)](#), followed by 5000 cycles of flexing to the position specified in Clause [5.18.2\(b\)](#). The rate of flexing shall be 6 – 10 cycles per minute, except that a faster rate of flexing may be employed, if agreeable to those concerned.

5.19 Physical abuse

5.19.1 General

5.19.1.1 An appliance employing enclosures in accordance with Exception No. 2 of Clause [4.2.1.2](#), the Exception to Clause [4.2.1.3](#), or Clause [5.21](#), shall withstand the impacts described in Clause [5.19.2](#) or [5.19.3](#), as applicable, without occurrence of any of the following:

- a) A reduction of spacings below the minimum specified values;
- b) Exposure of insulated or uninsulated live parts as determined by accessibility of live parts, Clause [4.2.5](#);
- c) Any other condition that would increase the risk of electric shock; and
- d) Any condition that would increase the risk of injury to persons resulting from operation of the appliance.

5.19.1.2 Following the applicable impact, metal enclosure parts of the sample shall comply with the dielectric voltage-withstand test, Clause [5.11](#).

5.19.1.3 For a utility vacuum cleaner provided with a float (filter) cage that serves as an enclosure or guard of hazardous moving parts, if the cage is dislodged from the enclosure as a result of the impact test, this shall be considered acceptable if the appliance complies with the following:

- a) The cage is not damaged and retains its original form;
- b) The cage is capable of being replaced by the user;
- c) The appliance is provided with the cautionary marking specified in Clause [11.4.28](#); and
- d) The appliance is provided with the instructions specified in Clause [12.5.18](#).

5.19.2 Drop impact

5.19.2.1 Appliances completely supported in the hand or by the body during use shall withstand being dropped three times on a hardwood floor from a height of 0.91 m (3 ft). The sample shall be positioned so that the sample strikes the surface in a position different from those in the other two drops. The hardwood surface shall consist of a layer of nominal 25-mm (1-in) tongue-and-groove oak flooring mounted on two layers of nominal 19-mm (3/4-in) fir plywood. The oak flooring shall be 19-mm (3/4-in) by 57-mm (2-1/4-in) thick. The assembly shall rest on a concrete floor, or an equivalent nonresilient floor, during the test.

5.19.2.2 A wet pick-up appliance that is completely supported in the hand or by the body during use shall be additionally subjected to the test described in Clause [5.19.2.1](#) when filled to maximum capacity with water prior to each drop. For an appliance with separate tanks for clean solution and recovery, only one tank shall be filled. In determining compliance with Clause [5.19.1\(c\)](#), the water shall not be investigated as a condition that would increase the risk of electric shock.

5.19.3 Ball impact

5.19.3.1 Stationary, fixed, or floor-supported equipment shall withstand an impact of 6.8 J (5 ft·lb) from a solid, smooth, steel sphere 51 mm (2 inch) in diameter and weighing approximately 0.5 kg (1.18 lbs) while the equipment is supported against or on a rigid surface that prevents the equipment from moving as a result of the impact. The impact shall be applied to any location considered exposed to a blow in normal use but not to brush caps or the actuating mechanism of switches.

5.19.4 Brush caps and switch actuators

5.19.4.1 Accessible motor brush caps and the actuating mechanism of switches and controls shall withstand a single impact applied by the impactor shown in [Figure 9](#) dropped from a height of 610 mm (2 ft) onto the cap or actuator. As a result of the test:

- a) Spacings shall not be reduced below the minimum values specified in spacings, [Clause 4.15](#);
- b) Insulated or uninsulated live parts shall not be exposed as determined by accessibility of live parts, [Clause 4.2.5](#);
- c) A switch shall remain mounted (see [Clause 4.3](#)); and
- d) For an appliance provided with double-insulation, the double-insulation system shall remain intact.

5.19.5 Deflection

5.19.5.1 An appliance employing a metal enclosure in accordance with Exception No. 2 of [Clause 4.2.1.2](#), or the Exception to [Clause 4.2.1.3](#) shall be subjected to the deflection test specified in [Clause 5.19.5.2](#), and shall comply with [Clause 5.19.1.1](#) (a) – (d).

5.19.5.2 A force of 111 N (25 lbs) shall be applied for 1 min to any area of the enclosure accessible after installation by means of a 12.7-mm (1/2-in) diameter hemisphere.

5.19.6 Vibration test

5.19.6.1 A vacuum cleaner intended for R/V or marine vessel installation shall withstand 12 h of vibration without:

- a) Leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; and
- b) Reduction of electrical spacings to less than minimum acceptable values.

Exception: A product intended for marine vessel installation marked in accordance with the requirement in [Clause 11.4.33](#) need not comply with the vibration test.

5.19.6.2 A sample shall be mounted to the platform of a vibration machine in accordance with the manufacturer's installation instructions and connected to a source of rated supply.

5.19.6.3 The sample shall be subjected to a variable-frequency vibration test along each of three rectilinear axes (two perpendicular horizontal axes and a vertical axis) for 4 h in each plane at a peak-to-peak amplitude (total platform displacement) of 0.51 ± 0.06 mm (0.020 ± 0.002 in). The frequency of vibration shall be continuously varied, at a uniform rate, from 10 to 60 to 10 cycles per second every 4 min.

5.19.7 Shock test

5.19.7.1 A vacuum cleaner intended for R/V or marine vessel installation shall withstand 1000 shock impacts without:

- a) Leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; and
- b) Reduction of spacings to less than the minimum acceptable values.

Exception: A product intended for marine vessel installation marked in accordance with the requirement in Clause [11.4.33](#) need not comply with the Shock Test.

5.19.7.2 The sample used for the Vibration Test, Clause [5.19.6](#), shall be used for this test. The sample shall be mounted on the platform of a shock machine, as specified in Clause [5.19.6.2](#), with its center of gravity as close as possible to the geometric center of the machine platform, and connected to a source of rated power supply.

5.19.7.3 The sample shall be subjected to 1000 vertical shock impacts, each having a 10 g peak acceleration [98 m/s^2 (322 ft/s^2)] and a duration of 20 to 25 ms as measured at the base of the half sine shock envelope.

5.19.7.4 Following this test, the sample shall be subjected to the Temperature Test, Clause [5.8](#), and the Dielectric Voltage-Withstand Test, Clause [5.11](#).

5.19.8 Salt-spray corrosion test (for marine vessel installation)

5.19.8.1 Metal alloys and corrosion-resistant finishes not known to be inherently resistant to corrosion shall be tested for equivalence to the materials specified in Clause [4.4.6](#). The metal alloys shall be subjected for 200 h to the tests described in ASTM B117. The results are acceptable if there is no pitting, cracking, or other deterioration more severe than that resulting from a similar test on passivated AISI Type 304 stainless steel.

5.20 Strength of handles

5.20.1 To determine whether an appliance complies with the requirements in Clause [4.20.6.1](#), the weight of the appliance plus a force of three times its weight shall be used. The load shall be uniformly applied over a 76.2-mm (3-in) width at the center of the handle without clamping. The load shall be started at zero and gradually increased so that the test value is reached in 5 to 10 s and shall be maintained for 1 min. When more than one handle is furnished on an appliance, and the appliance is unable to be carried by one handle, the force shall be distributed between the handles. The distribution of force shall be determined by measuring the percentage of the appliance weight sustained by each handle with the appliance in the normal carrying position. When an appliance is furnished with more than one handle and can be carried by only one handle, each handle shall sustain the total force. A wet pick-up type appliance that is completely supported in the hand or by the body during use shall be filled to maximum normal capacity with water when determining the weight of the appliance and during the test. For an appliance with separate tanks for clean solution and recovery, only the largest tank shall be filled to maximum normal capacity with water during the test.

5.21 Polymeric enclosure parts

5.21.1 Volume resistivity

5.21.1.1 The volume resistivity of the polymeric material shall be:

- a) Not less than 50 MΩ-cm after conditioning for 40 h at $23 \pm 2^\circ\text{C}$ ($73 \pm 4^\circ\text{F}$) and $50 \pm 5\%$ relative humidity; and
- b) Not less than 10 MΩ-cm after exposure for 96 h to moist air having a relative humidity of $90 \pm 5\%$ at a temperature of $35 \pm 2^\circ\text{C}$ ($95 \pm 4^\circ\text{F}$).

Exception No. 1: A polymeric material having a volume resistivity lower than that required may be used if, with the enclosure considered to be a noncurrent-carrying metal part, the product complies with the requirements for spacings in Clause [4.15](#).

Exception No. 2: In lieu of volume resistivity, compliance with the end-product leakage-current requirements (Clause 5.3) is acceptable. Leakage current measurement shall be taken from accessible surfaces of the polymeric material in question.

5.21.1.2 The volume resistivity shall be determined in accordance with UL 746A.

5.21.2 Resistance to hot-wire ignition

5.21.2.1 For a portable appliance, a polymeric material shall resist being ignited for 7 s or longer (PLC 4 – see note a of Table 4) when subjected to the hot wire ignition test described in UL 746A.

Exception No. 1: The test need not be conducted if the electrically live parts, including all internal wiring, are spaced 12.7 mm (1/2 in) or more from the material.

Exception No. 2: Materials that do not comply with the minimum HWI requirements specified in Table 4 shall comply with:

- a) The Abnormal overload test, Clause 5.26;
- b) The Glow-wire end-product test, Clause 5.27; or
- c) The UL 746A glow-wire ignitability test as follows:

1) The material shall have a glow-wire flammability index (GWFI) rating of at least the required glow-wire temperature specified in Table 13 of this end-product standard; or the material shall have a glow-wire ignition temperature (GWIT) rating of at least 25°C higher than the required glow-wire temperature specified in Table 13 of this end-product standard; and

2) The GWFI or GWIT rating shall be in a thickness that is within ± 0.1 mm (± 0.004 in) of the relevant end-product part, or if the rating is for a range of thicknesses, the relevant end-product part shall have a thickness within that range.

5.21.2.2 For a stationary or fixed appliance, a polymeric material shall resist being ignited for 15 s or longer (PLC 3 – see note a of Table 4) when subjected to the hot-wire ignition test.

Exception No. 1: The test need not be conducted if the electrically live parts, including all internal wiring, are spaced 12.7 mm (1/2 in) or more from the material.

Exception No. 2: Materials that do not comply with the minimum HWI requirements specified in Table 4 shall comply with:

- a) The Abnormal overload test, Clause 5.26;
- b) The Glow-wire end-product test, Clause 5.27; or
- c) The UL 746A glow-wire ignitability test as follows:

1) The material shall have a glow-wire flammability index (GWFI) rating of at least the required glow-wire temperature specified in Table 13 of this end-product standard; or the material shall have a glow-wire ignition temperature (GWIT) rating of at least 25°C higher than the required glow-wire temperature specified in Table 13 of this end-product standard; and

2) The GWFI or GWIT rating shall be in a thickness that is within ± 0.1 mm (± 0.004 in) of the relevant end-product part, or if the rating is for a range of thicknesses, the relevant end-product part shall have a thickness within that range.

5.21.3 Mold stress-relief distortion

5.21.3.1 Conditioning of the appliance as described in Clause [5.21.3.2](#) shall not cause softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion of the enclosure, as judged after cooling to room temperature, that results in any of the following:

- a) Reduction of spacings between uninsulated live parts of opposite polarity, uninsulated live parts and accessible noncurrent-carrying or grounded metal, uninsulated live parts and the enclosure to less than the minimum specified values specified in spacings, Clause [4.15](#);
- b) Making uninsulated live parts or internal wiring accessible to contact as determined by accessibility to live parts, Clause [4.2.5](#);
- c) Causing a condition that results in the appliance not complying with the power-supply-cord strain-relief requirements in Clause [5.21.6.1](#), if applicable; or
- d) Defeating the integrity of the enclosure so that mechanical protection in accordance with Clause [4.2.1](#) is not afforded to internal parts of the appliance.

Exception: The conditioning described in Clause [5.21.3.2](#) is not required for rigid thermosetting materials or for low-pressure foamed molded parts.

5.21.3.2 One sample of the complete appliance shall be placed in a full-draft circulating air oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under normal operating conditions but not less than 70°C (158°F). The sample shall remain in the oven for 7 h. After its careful removal from the oven and return to room temperature, the sample shall be investigated for compliance with Clause [5.21.3.1](#).

5.21.4 Impact

5.21.4.1 The appliance shall be subjected to the applicable impact described in Clause [5.19](#).

5.21.4.2 Each of three samples of an appliance intended for outdoor use shall be cooled to a temperature of $\text{minus } 35.0 \pm 2.0^{\circ}\text{C}$ ($\text{minus } 31.0 \pm 3.6^{\circ}\text{F}$) and maintained at this temperature for 3 h. While the unit is still cold, the samples shall be subjected to the applicable impact described in Clause [5.19](#).

Exception: For an appliance marked in accordance with Item 3, 5, or 11 of [Table 18](#), the conditioning temperature shall be $0 \pm 2^{\circ}\text{C}$ ($32 \pm 3.6^{\circ}\text{F}$).

5.21.5 Severe conditions

5.21.5.1 An appliance shall be conditioned as described in Clause [5.21.5.3](#) and:

- a) During conditioning, there shall be no:
 - 1) Flaming of the material upon which the appliance is placed or with which it is draped, or
 - 2) Ignition of the enclosure material; and

b) After conditioning, the appliance shall comply with the mold stress-relief distortion requirements in Clause [5.21.3.1](#) (a), (b), and (d).

5.21.5.2 For an appliance conditioned as described in Clauses [5.9.1.1](#) and [5.21.5.3](#) (b) and (c), the no-load current input to the appliance shall not be greater than 150% of the no-load current input of the appliance measured on an unconditioned sample.

5.21.5.3 An appliance shall be subjected to the applicable conditions in (a), (b), or (c):

a) An appliance that employs a motor, the only function of which is to move air, shall be conditioned as noted in Clause [5.21.5.4](#);

b) An appliance that employs a motor to perform a function other than to move air shall be tested as specified in Clause [5.9.1.1](#); or

c) An appliance that employs a dual-purpose motor, one function of which is to move air, shall be tested as noted in Clauses [5.9.1.1](#) and [5.21.5.4](#).

5.21.5.4 An appliance as described in Clause [5.21.5.3](#) (a) and (c) shall be placed on a single layer of white tissue paper on a softwood surface and shall be draped with a single layer of cheesecloth. The sample shall be operated for a period of 7 h with the air intake completely open and for a period of 7 h with the air inlet completely blocked. During the open inlet condition, a hole shall be cut in the cheesecloth to accommodate the vacuum air inlet. A separate sample may be used for each condition.

Exception: For a product that employs a flow-through type vacuum motor, the open inlet condition need not be conducted.

5.21.5.5 During the conditioning mentioned in Clauses [5.21.5.2](#) – [5.21.5.4](#):

a) A motor-protective device may be retained in the circuit if it complies with the requirements for temperature and endurance under locked-rotor conditions in C22.2 No. 77 and UL 1004-3.

b) A temperature-sensitive device, such as a thermostat, may be retained in the circuit provided it:

1) Complies with the requirements for an automatically resetting or manual resetting appliance temperature limiting controls in C22.2 No. 24 and UL 873, with a minimum appliance control endurance level of 6000 cycles;

2) Has an acceptable electrical rating for the load controlled; and

3) Complies with the requirement in Clause [4.9.3.5](#).

c) A mechanical air-flow valve that functions during the blocked inlet test of Clause [5.21.5.4](#) shall comply with the endurance test requirements specified in Clause [5.31](#).

Exception No. 1: A temperature limiter that complies with CAN/CSA-E60730-2-9 and UL 60730-2-9 and is suitably rated for the voltage, current, and load it controls, and has been evaluated as a Type 1C (control for microinterruption) or for manual action, with 6000 cycles of endurance, is considered to comply with the requirements of UL 873 as specified in item (b) above.

Exception No. 2: An electronic temperature control that complies with Clause [4.11.4](#) is considered to comply with this requirement.

5.21.6 Strain-relief after mold stress-relief distortion

5.21.6.1 After the test samples have cooled to room temperature following the oven conditioning described in Clause [5.21.3](#), the sample shall be subjected to the strain-relief test, Clause [5.14](#), and shall comply with the requirements.

5.21.7 Abnormal operation – Polymeric enclosure parts

5.21.7.1 When tested as described in Clause [5.21.7.2](#), there shall be no ignition of the enclosure material or exposure of live parts. There shall be no ignition of the combustible material that the appliance is placed on or draped with as a result of emission of flame through other than existing openings.

5.21.7.2 The appliance shall be operated under the conditions of abnormal operation that are appropriate for the product, such as stalled-rotor operation. During the test, the appliance shall rest on white tissue paper on a softwood surface. A single layer of cheesecloth shall be draped over the entire appliance and the appliance shall be operated continuously until the ultimate results have been determined. In most cases, continuous operation for 7 h may be necessary to obtain the ultimate results. The simulated abnormal conditions shall be imposed one at a time. A new sample may be used to evaluate any or all conditions of abnormal use. With respect to ignition of the cheesecloth or supporting surface, flames emitted from existing openings shall be disregarded. However, sustained flames from the appliance shall not be extinguished. The cheesecloth shall be removed and the test shall be continued until ultimate results have been determined.

5.21.8 Exposure to ultraviolet light

5.21.8.1 A polymeric material used for the enclosure of an electrical appliance that is intended to be used outdoors and is not marked per Item 3, 5, or 11 of [Table 18](#) shall be acceptably resistant to degradation when exposed to ultraviolet light.

5.21.9 Crushing resistance

5.21.9.1 Stationary and fixed appliances shall withstand a 1-min application of the crushing force described in Clause [5.21.9.2](#) without resulting in any of the following:

- a) Reduction of spacings below the minimum values specified in Clause [4.15](#);
- b) Accessibility to contact of uninsulated live parts of internal wiring;
- c) Such breakage, cracking, rupture, and the like as to adversely affect the insulation; or
- d) Production of any other condition that would increase the risk of electric shock or fire during the intended use of the appliance.

5.21.9.2 Three samples of an appliance shall be backed on the mounting side by a fixed rigid supporting surface. The crushing force shall be applied to the side opposite the mounting surface, and by flat surfaces each 102 by 254 mm (4 by 10 in). Each force applicator shall exert 45.4 kg (100 lbs) on the sample. As many applicators shall be applied as the sample can accommodate on the surface opposite the mounting surface, based on an arrangement of applicators as indicated in [Figure 10](#).

5.21.10 Thermal aging

5.21.10.1 A material used for the enclosure shall be resistant to thermal degradation at the maximum temperature to which it is exposed during normal use of the appliance. The thermal-aging characteristics of the material shall comply with one of the following:

- a) The material shall have a relative temperature index, based on historical data or a long-term thermal aging program, in accordance with C22.2 No. 0.17 and UL 746B, which indicates acceptability for use at the temperature involved; or
- b) The polymeric material may be considered appropriate from a thermal-aging standpoint if the maximum temperature to which it is exposed during normal use of the appliance does not:
 - 1) Exceed 80°C (176°F) for an attended, intermittent-duty household use appliance;
 - 2) Exceed 65°C (149°F) for any other portable appliance; and
 - 3) Exceed 50°C (122°F) for all other appliances.

5.22 Polymeric materials used as structural support

5.22.1 An appliance that employs a polymeric material for the structural support of a motor-driven cleaning brush, a motor bearing, or the like, including part or all of an enclosure, where deterioration or breakage could result in excessive overload of the motor, shall be subjected to the impact tests specified in Clause [5.19.2](#) or [5.19.3](#) and the mold stress-relief distortion test, Clause [5.21.3](#). As a result of each test, the appliance shall have an input current not greater than 150% of the current measured during the applicable input test conducted on the unconditioned sample with the air-intake open.

Exception: This requirement does not apply to polymeric material used for the support of bearings of a belt-driven part if stalling of the part will not result in stalling of the motor.

5.23 Adhesives

5.23.1 General

5.23.1.1 An adhesive as mentioned in Clause [4.2.4](#) shall be subjected to the tests specified in Clauses [5.23.2](#) – [5.23.6](#). Unless otherwise specified, all testing shall be conducted in a standard laboratory atmosphere at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5% relative humidity.

5.23.1.2 Specimens shall be prepared that represent the use of the adhesive in the application, including fabrication, surface preparation, and the temperature and pressure application during bonding.

5.23.2 As-received test

5.23.2.1 Twenty specimens shall be conditioned for 40 h at 23.0 ±2.0°C (73.0 ±3.6°F) and a relative humidity of 50 ±5% prior to testing.

5.23.2.2 The specimens shall be subjected to applicable tests to determine the value of the bond-strength in the as-received condition. Specimens that break at an obvious flaw remote from the adhesive line shall be discarded and a retest conducted. The average value of the bond-strength shall be computed. This value shall be used for comparison with values for bond-strength after the environmental conditioning described in Clauses [5.23.3](#) – [5.23.6](#).

5.23.3 Effect of temperature

5.23.3.1 Ten specimens shall be conditioned for 1000 h at the oven temperature taken from the respective thermal-endurance-profile line in [Figure 11](#), where the temperature index T is the measured normal operating temperature (see Clause [5.8](#)) of the adhesive, but not less than 60°C (140°F).

Exception No. 1: On the same thermal-endurance-profile line in [Figure 11](#), a shorter or longer time at a higher or lower temperature respectively may be employed if agreeable to all concerned, but a period no less than 300 h shall be used.

Exception No. 2: A motor that complies with any of the following standards need not be subjected to the tests in [Clause 5.23](#):

- a) UL 1004-1; or*
- b) C22.2 No. 77 and UL 1004-2; or*
- c) C22.2 No. 77 and UL 1004-3.*

Exception No. 3: A double insulated motor subjected to [Clauses 6.16](#) and [6.17](#) need not be subjected to this test.

5.23.3.2 After the conditioning, the specimens shall be brought to and tested at room temperature to determine the bond-strength values. The average conditioned value shall be at least 50% of the unconditioned value.

5.23.4 Effect of humidity

5.23.4.1 Ten specimens shall be conditioned for 7 days at 95 – 100% relative humidity at $60 \pm 1^{\circ}\text{C}$ ($140 \pm 1.8^{\circ}\text{F}$).

5.23.4.2 After the conditioning, the specimens shall be brought to and tested at room temperature to determine the bond-strength values. The average conditioned value shall be at least 50% of the unconditioned value.

5.23.5 Effect of cyclic conditions

5.23.5.1 Ten specimens shall be subjected to three complete cycles of the conditioning indicated in [Table 11](#).

5.23.5.2 After the conditioning, the specimens shall be brought to and tested at room temperature to determine the bond-strength values. The average conditioned value shall not be less than 50% of the unconditioned average value.

5.23.6 Effect of cold

5.23.6.1 There shall be no visual signs of cracking or chipping of the bond between the two adhered parts of the specimens after conditioning for 24 h at $\text{minus } 35 \pm 1^{\circ}\text{C}$ ($\text{minus } 31 \pm 1.8^{\circ}\text{F}$) for outdoor-use applications and at $0 \pm 1^{\circ}\text{C}$ ($32 \pm 1.8^{\circ}\text{F}$) for indoor-use applications. At least six specimens shall be subjected to the cold conditioning.

5.24 Thermoplastic motor insulation systems

5.24.1 General

5.24.1.1 Motors that employ thermoplastic materials to electrically isolate the windings and similar live parts from other live parts or noncurrent-carrying metal parts shall be subjected to the tests in [Clauses 5.24.2](#) and [5.24.3](#).

Exception No. 1: A motor that serves to move air only with a direct mounted fan need not be subjected to the test in Clause [5.24.3](#).

Exception No. 2: A motor that complies with any of the following standards need not be subjected to the tests in Clause [5.24](#):

- a) UL 1004-1; or*
- b) C22.2 No. 77 and UL 1004-2; or*
- c) C22.2 No. 77 and UL 1004-3.*

Exception No. 3: A double insulated motor subjected to Clauses [6.16](#) and [6.17](#) need not be subjected to this test.

5.24.2 Abnormal conditioning

5.24.2.1 The motor shall be subjected to the abnormal conditioning described in Clause [5.24.2.2](#) and shall comply with all of the following conditions:

- a) The 3-A fuse shall remain intact; and
- b) The material under test shall withstand, without breakdown, the dielectric voltage-withstand potential specified in Clause [5.11](#) immediately following the conditioning specified in Clause [5.24.2.2](#) and with the 3-A fuse removed from the circuit.

5.24.2.2 The motor shall be operated with the armature locked until ultimate results have been determined or for 7 h, whichever occurs first. Noncurrent-carrying metal parts of the motor that are insulated by the material under test shall be connected to ground through a 3-A, quick-acting, plug type fuse.

5.24.3 Running overload

5.24.3.1 Thermoplastic insulating material employed in motors with a stalled-rotor current greater than twice the normal operating current shall comply with all of the following after the overload-burnout conditioning described in Clauses [5.24.3.2](#) and [5.24.3.3](#):

- a) The 3-A fuse shall not rupture as a result of deterioration of the thermoplastic motor insulation system under test; and
- b) The thermoplastic material under test shall comply with the dielectric voltage-withstand test described in Clause [5.11](#) immediately following the overload-burnout conditioning.

Exception: A double-insulated appliance shall be tested in accordance with overload test on motors, Clause [6.17](#).

5.24.3.2 For vacuum cleaners and blower cleaners, each of three samples of the motor shall be subjected to operation at normal load for 1 h. Immediately following operating at normal load, the load shall be increased in steps of 10% of the rated current for each of four successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min until the motor burns out. During the test, noncurrent-carrying metal parts of the motor that are insulated by the material under test shall be connected to ground through a 3-A, quick-acting fuse.

5.24.3.3 For household use floor finishing machines, each of three samples of the complete product shall be subjected to operation at no load for 1/2 h, immediately followed by operation at normal load for 1/2 h.

Immediately following this, the load shall be increased in steps of 10% of the rated current for each of four successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min until the motor burns out. During the test, noncurrent-carrying metal parts of the motor that are insulated by the material under test shall be connected to ground through a 3-A, quick-acting fuse.

5.24.4 Thermal aging

5.24.4.1 A polymeric material employed in a Class 105 (A) motor insulation system in accordance with Exception No. 1 to Clause [4.9.1.9](#) shall be aged for the amount of time corresponding to an aging temperature that appears on the Class 105 (A) system response shown in [Figure 12](#). The motor insulation system shall cool to room temperature and the applicable dielectric voltage-withstand requirements specified in Clause [5.11](#) shall be applied between live parts and noncurrent-carrying metal parts that are isolated from each other by the material under consideration.

5.25 End-product arc resistance

5.25.1 A polymeric material employed in accordance with Exception No. 2 to Clause [4.8.2](#) shall be tested as specified in Clause [5.25.2](#). There shall be no ignition:

- a) Within 15 arcs for materials classed V-0;
- b) Within 30 arcs for materials classed V-1, and V-2; or
- c) Within 60 arcs for materials classed HB.

5.25.2 The flammability ratings are in accordance with C22.2 No. 0.17 and UL 94. In addition, there shall not be a permanent conductive carbon path judged by application of a dielectric voltage-withstand potential between the live part and the adjacent part of different potential, as required in dielectric voltage-withstand, Clause [5.11](#).

5.25.3 The current for the arcing test shall be based upon the normal load-current rating and minimum power factor. The voltage used for the test shall be equal to the available voltage at the live part. The arc shall be established between the live part and any adjacent part where breakdown is likely to occur. The arc shall be used to attempt to ignite materials forming parts of the enclosure or to ignite materials located between the parts of different potential. The arc shall be established by means of a copper or stainless steel conductive probe. The conductive probe shall be used to create arc tracking or a carbon build-up across the surface of the insulating material at the rate of 40 arc separations per minute. (A rate of 30 arc separations per minute may be used if 40 arc separations per minute is not practical.)

5.26 Abnormal overload

5.26.1 A polymeric material employed in accordance with Exception No. 3 to Clause [4.8.2](#) shall be capable of withstanding the temperatures that are generated during or as a result of passing the abnormal currents through the live parts that are in contact with or within 0.79 mm (1/32 in) of the insulating material without ignition, undue distortion, or melting of the material being evaluated. The value of the abnormal current and the time shall be as specified in [Table 12](#). See Clauses [5.26.2](#) and [5.26.3](#).

5.26.2 If there is no overcurrent protective device provided as part of the equipment or it cannot be relied upon, evaluation shall be based upon the available energy to the end-product using percentages of the intended branch-circuit overcurrent device, but not less than a 30 A normal-acting protective device.

5.26.3 If an overcurrent protective device is provided as part of the equipment, it shall be relied upon only if the device is not user-serviceable unless substitution of a device with a higher-rated value is unlikely due to keying or other constructional features.

5.27 Glow-wire end-product test

5.27.1 A polymeric material employed in accordance with Exception No. 4(b) of Clause [4.8.2](#) and Exception No. 2(b) of Clauses [5.21.2.1](#) and [5.21.2.2](#) shall be capable of withstanding the effects of an electrically heated wire as described in the glow-wire end-product test (GWEPT) specified in C22.2 No. 0.17 and UL 746C.

5.27.2 The specimen is considered to have satisfactorily withstood the glow-wire end-product test if either:

- a) There is no ignition; or
- b) All flaming and glowing of the part and the flaming particle indicator ceases within 30 ± 1 s after removal of the glow-wire. The results are not acceptable if the part or the flaming particle indicator are completely consumed.

5.27.3 The glow-wire temperature shall be as specified in [Table 13](#) of this end-product standard.

5.28 Blower cleaner impeller tests

5.28.1 General

5.28.1.1 A blower cleaner shall withstand the test described in Clause [5.28.2](#), without occurrence of any of the following:

- a) Parts of the impeller being ejected from the blower;
- b) Cracks or other damage to the impeller that are visible to the naked eye upon inspection;
- c) Any other condition that would increase the risk of injury to persons resulting from operation of the appliance.

5.28.2 Overspeed

5.28.2.1 A blower cleaner provided with a series motor shall be operated while set to its highest speed at a voltage equal to 1.3 times the rated voltage for 1 min.

Exception: This test is not applicable for battery-operated blower cleaners.

5.28.2.2 A blower cleaner provided with a series motor and thermoplastic fan shall also be subjected to the test in Clause [5.28.2.1](#) after the following oven conditioning. One sample of the complete appliance shall be placed in a full-draft circulating air oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under normal operating conditions but not less than 70°C (158°F). The sample shall remain in the oven for 7 h. After its careful removal from the oven and return to room temperature, the sample shall be tested in accordance with Clause [5.28.2.1](#) and then investigated for compliance with Clause [5.28.1.1](#).

Exception: This test is not applicable for battery-operated blower cleaners.

5.29 Integral insulation

5.29.1 Samples of a wound component, stator, or rotor having integral insulation (e.g., epoxy coating) in lieu of slot liners, for use in machines rated 250 V and less, shall be subjected to the tests described in Clauses [5.29.2](#) through [5.29.7](#).

5.29.2 The components shall be subjected to a dielectric strength test of 1000 V for 1 min without breakdown, except that where the wound component is for use in machines rated above 250 V, the components shall be subjected to a dielectric strength test of 1000 V plus twice the rated voltage for 1 min without breakdown.

5.29.3 The samples shall be subjected to one of the following conditioning cycles, and then followed by a conditioning of 24 h at 30°C (86°F) at a relative humidity of 80 to 90%. A temperature tolerance of $\pm 2^\circ\text{C}$ ($\pm 3.6^\circ\text{F}$) shall be permitted:

- a) 24 h at 175°C (347°F) for Class A;
- b) 24 h at 200°C (392°F) for Class B; or
- c) 24 h at 220°C (428°F) for Class F insulation.

5.29.4 The conditioning cycle described in Clause [5.29.3](#) shall be repeated once, and then the samples shall be immersed in a hard water solution of 0.5 g of calcium sulphate (CaSO_4) per liter of distilled water for 24 h at a temperature of $25 \pm 2^\circ\text{C}$ ($77 \pm 3.6^\circ\text{F}$).

5.29.5 The samples shall be air dried in an essentially draft-free area for not less than 7 h at $20 \pm 5^\circ\text{C}$ ($68 \pm 9^\circ\text{F}$) with a max RH of 50%.

5.29.6 The insulation resistance of the samples shall be measured using 500 Vdc at $20 \pm 5^\circ\text{C}$ ($68 \pm 9^\circ\text{F}$) with a max RH of 50%. The insulation resistance shall be not less than 500 k Ω .

5.29.7 The dielectric strength test described in Clause [5.29.2](#) shall be repeated, and all samples shall pass without breakdown.

5.30 Testing of temperature control devices used in a vacuum with a steam-cleaning attachment

5.30.1 Overload test for automatic temperature controls

5.30.1.1 An automatic control for temperature regulating or temperature limiting shall be capable of performing successfully for 50 cycles of operation when the sheathed heating element of the steam cleaner is connected to a supply circuit having a potential of 120% of the voltage specified in Clause [5.1](#). There shall be neither electrical nor mechanical malfunction of the control, nor undue burning, pitting, or welding of the contacts.

5.30.1.2 In tests to determine whether an automatic control complies with the requirements in Clause [5.30.1.1](#), the appliance shall be connected to a grounded supply circuit; the enclosure of the product, if of metal, shall be connected to ground through a 3-A fuse; and the control, if single-pole, shall be connected in an ungrounded conductor of the circuit. If the heating element is intended for use on direct current, or on direct current as well as on alternating current, the test shall be conducted with direct current, and the enclosure shall be so connected as to be positive with respect to a single-pole automatic control. The device shall be operated at the rate of 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection opens during the test.

5.30.2 Endurance test for thermostats

5.30.2.1 A thermostat shall be capable of withstanding an endurance test consisting of the number of cycles indicated in [Table 22](#). Unless it is specified that the test be made without load, the thermostat shall make and break the rated current of the appliance while connected to a circuit of rated voltage. There shall be neither electrical nor mechanical malfunction of the thermostat, nor undue burning, pitting, or welding of the contacts.

5.30.2.2 With reference to Clause [5.30.2.1](#) and [Table 22](#), thermostats are classified as follows:

- a) A temperature-regulating thermostat is one that functions only to regulate the temperature of the appliance under intended conditions of use, and whose malfunction would not result in a risk of fire.
- b) A temperature-limiting thermostat is one that functions only under conditions that produce abnormal temperatures. The malfunction of such a thermostat might or might not result in a risk of fire.
- c) A combination temperature-regulating and -limiting thermostat is one that functions to regulate the temperature of the appliance under intended conditions of use, and also serves to reduce the risk of fire that might result from conditions of abnormal operation of the product.

5.31 Mechanical valve endurance test

5.31.1 With reference to Clauses [5.2.1.4](#), [5.2.2.2](#), and [5.21.5.5\(c\)](#), the mechanical air-flow valve shall be subjected to 6000 cycles of operation by blocking and unblocking the vacuum air inlet so as to fully actuate the mechanical valve. The cycle rate shall be a minimum of 6 cycles per minute.

5.31.2 As an alternative to testing the valve in the vacuum cleaner, a mechanical air-flow valve may be bench tested using prescribed or declared end-use air-flow parameters to determine compliance.

5.31.3 For a valve that uses polymeric materials in its construction, a second sample of the valve shall be placed in a full-draft circulating air oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under normal operating conditions but not less than 70°C (158°F). The sample shall remain in the oven for 7 h. After its careful removal from the oven and return to room temperature, the valve shall be tested in accordance with Clause [5.31.1](#) and comply with Clause [5.31.4](#).

5.31.4 As a result of the testing the valve shall operate as intended and the valve shall still be functional at the completion of the test.

5.32 General purpose transformers

5.32.1 General

5.32.1.1 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 Clauses [5.32.2](#) – [5.32.4](#).

5.32.2 Voltage measurement test

5.32.2.1 For purposes of comparison with voltages measured as described in the Overload Test of Clause [5.32.3](#), each secondary open-circuit voltage shall be measured with the primary connected to a test voltage and frequency supply source as indicated in Clause [5.1](#).

5.32.3 Overload test

5.32.3.1 A transformer shall be subjected to the test conditions described in Clause [5.32.3.2](#). The stabilized surface or core temperature recorded on the transformer during the second 50% load operation shall not be more than 5°C (9°F) greater than the stabilized core temperature obtained during the initial 50% of load operation. The open-circuit output voltage determined following the final 50% load operation shall be within 2% of the output voltage measured during the Voltage Measurement Test in Clause [5.32.2](#). As an option, a protective device, if provided, may be bypassed when conducting this test.

5.32.3.2 The transformer shall be operated as described in the Temperature Test in Clause 5.8, except that the load shall be 50% of the rated value, until the core, or surface temperatures if encapsulated, stabilize. After stabilization, the load shall be adjusted until 200% of rated secondary current is reached. After 2 min of operation, the load shall be readjusted, if necessary, to restore the current to 200%, but no further adjustment shall be made thereafter. The duration of this overload shall be 30 min. The load shall then be restored to the original 50% 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% load-current temperature (whichever occurs first). This temperature value shall be compared with the original 50% load stabilized condition, as specified in 5.32.3.1. 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.

5.32.3.3 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% load heating test.

5.32.3.4 A protective device, when provided, shall be bypassed when the device opens while the load is adjusted after the surface temperatures have stabilized.

5.32.4 Repeated dielectric voltage-withstand test

5.32.4.1 Following the Overload Test in Clause 5.32.3, the transformer shall be subjected to a repeated dielectric voltage-withstand test. The test potential shall be 65% of the value originally specified. After this test, the transformer shall perform as intended.

5.33 Interlock system endurance – Floor sweepers

5.33.1 An interlock system provided with a floor sweeper shall be subjected to the endurance test described in Clauses 5.33.2 and 5.33.3. As a result of the test:

- a) There shall not be any electrical or mechanical malfunction of the interlock system, or undue pitting or burning of the switch contacts; and
- b) The fuse in the grounding connection shall not open.

5.33.2 To determine if an interlock system complies with the requirements in Clause 5.33.1, the appliance shall be connected to a grounded power-supply circuit of rated frequency and voltage. During the test, exposed dead metal parts of the appliance shall be connected to ground through a 3-A non-time-delay plug fuse and the connection shall be such that any single-pole current interrupting device is in an ungrounded conductor of the supply circuit.

5.33.3 The interlock system shall be operated for 100,000 cycles at a maximum rate of 6 cycles per minute. One cycle shall consist of removing the dust container to the point where the interlock switch opens, and then replacing the dirt container into the appliance. The interlock switch shall be operated at a cycle rate of one-second "on" and nine-seconds "off". A faster or slower cycle rate may be used if acceptable to those involved.

6 Double Insulation

6.1 Scope

6.1.1 These requirements apply to appliances marked as being provided with double insulation and to appliances that employ double insulation in place of grounding in accordance with the Exception to Clause [4.16.1](#). These requirements supplement those contained elsewhere in this standard.

6.2 Definitions

6.2.1 See Clause [3](#).

6.3 Construction – general

6.3.1 The appliance shall be so constructed that double insulation is interposed between all live parts and each of the following:

- a) All accessible surfaces of the appliance; and
- b) Parts that are conductively connected to accessible noncurrent-carrying metal parts or surfaces.

Exception: A construction using reinforced insulation complying with Clause [6.4](#) may be used in place of double insulation.

6.3.2 The thickness and the resistance to deterioration with aging of a material employed as supplementary insulation shall not be less than that required for the same material employed as basic insulation.

6.3.3 The insulation qualities and resistance to deterioration with aging of a material employed as reinforced insulation shall not be less than the combination of basic and supplementary insulation.

6.3.4 The appliance shall be so constructed that the added protection against a risk of electric shock provided by the supplementary or reinforced insulation is not reduced by the abuses likely to be encountered during normal service (see Clauses [6.15](#), resistance to impact test, and [6.16](#), abnormal operation test).

6.3.5 The appliance shall be so constructed that the following parts are not accessible:

- a) A live part;
- b) A noncurrent-carrying metal part that is insulated from live parts by basic insulation only, unless it is reinforced insulation as described in Clause [6.4](#); and
- c) Basic insulation itself, unless it is reinforced insulation as described in Clause [6.4](#).

6.3.6 The appliance shall be constructed so that all parts – straps, screws, nuts, washers, springs, and the like – are secured so that they are not likely to become loosened or displaced if such loosening or displacement reduces the spacings to values below those specified in [Table 14](#).

Exception: If loosening or displacement of the part causes malfunctioning of the appliance and does not result in an accessible live part, the appliance need not be so constructed.

6.3.7 Parts secured by two independent fastenings or by means of screws or nuts provided with lockwashers are considered not likely to become loose, if these fastening means are not required to be removed during routine servicing.

6.3.8 Leakage, rupture or overfilling of a reservoir, pipe, tube, or the like for storing or conducting water or other fluid associated with the appliance shall not render either basic, reinforced, or supplementary insulation ineffective or result in deterioration of the insulation.

6.4 Reinforced insulation

6.4.1 General

6.4.1.1 Reinforced insulation may be used in place of double insulation anywhere in the appliance if the reinforced insulation consists of one or more layers with a total thickness of not less than 4.8 mm (3/16 in), and in locations as specified in Clauses [6.4.2](#) – [6.4.8](#). In a multilayer assembly, contact between adjacent layers is acceptable.

6.4.2 Brush caps and brush holders

6.4.2.1 Reinforced insulation is considered to exist in an accessible brush cap or brush holder if the construction complies with each of the following:

- a) The brush cap or brush holder shall be so recessed that, if it is mounted normally, its top is inside the plane of the opening in the surrounding portion of the enclosure of the appliance;
- b) The brush cap or brush holder shall be entirely composed of insulating material; and
- c) The construction complies with Clause [6.4.3](#) or [6.4.4](#), as applicable.

6.4.3 Brush holders in enclosures of insulating material

6.4.3.1 A brush holder assembly that is supported in the insulating material housing of the appliance shall have a total insulation thickness not less than 4.8 mm (3/16 in) and any path between parts of the enclosure shall be broken by barriers or the like so that there is no direct path from the outside to live parts of the brush holder assembly.

6.4.4 Brush holders in enclosures of conductive material

6.4.4.1 A brush holder mounted in an enclosure of conductive material shall have its own enclosure of insulating material and the construction shall comply with the following:

- a) All live parts of the brush holder assembly shall be enclosed in the enclosure of insulating material; and

Exception: The wiring terminals of the brush itself need not be enclosed.

- b) The enclosure of the brush holder assembly shall be separated from accessible noncurrent-carrying metal parts by any one or more of the following constructions:

- 1) Mica not thinner than 0.13 mm (0.005 in);
- 2) Other inorganic insulation having electrical properties at least equivalent to those of mica; or
- 3) Acceptable organic insulating material not less than 1.6-mm (1/16-in) thick.

6.4.5 Commutator and end turns of the armature winding

6.4.5.1 Reinforced insulation is considered to exist between the commutator segments and the shaft, or the end turns and the shaft, and in both locations, if the insulation consists of one or more of the following:

- a) Sheet mica that is not less than 0.13-mm (0.005-in) thick;
- b) Other inorganic insulation having electrical properties at least equivalent to those of mica. If such insulation is used under the commutator segments, the thickness of the insulation shall not be less than 2.0 mm (0.080 in). If such insulation is used under the end turns, the thickness of the insulation shall not be less than 1 mm (0.039 in) or the length of the air gap, whichever is larger; or
- c) Acceptable organic insulating material if the armature complies with the investigation of armature employing reinforced insulation, Clause [6.18](#).

6.4.5.2 If any of the constructions described in Clause [6.4.5.1\(b\)](#) are used, the armature laminations shall be insulated from the shaft by either of the following:

- a) Sheet mica that is not less than 0.13-mm (0.005-in) thick; or
- b) Other inorganic insulation having electrical properties at least equivalent to those of mica. The thickness of the insulation shall not be less than 1 mm (0.039 in) or the length of the air gap, whichever is larger.

6.4.6 Switches

6.4.6.1 Reinforced insulation is considered to exist at a switch if the switch has its own enclosure of insulating material and if the following conditions are met:

- a) A noncurrent-carrying metal part that extends outside of the switch enclosure shall not enter the arc chamber;
- b) The plunger, toggle or the like that contacts live parts inside the switch shall be entirely composed of insulating material;
- c) A live part inside the switch shall not be contacted by a metal actuating arm, cam, or the like;
- d) All live parts other than the terminals shall be completely enclosed in the switch enclosure;
- e) In an appliance employing a conductive enclosure, that portion of the switch or switch enclosure that contains arcing parts shall be separated from exposed noncurrent-carrying metal by means of not less than 0.13-mm (0.005-in) thick mica or by other insulation having at least the equivalent electrical properties, and any metal in contact with the switch enclosure shall be insulated from accessible noncurrent-carrying metal by supplementary insulation;
- f) In an appliance employing an enclosure of insulating material, metal mounting screws or rivets used to secure the switch to accessible noncurrent-carrying metal shall not pass through the body of the switch enclosure. The mounting means may pass through tabs, ears, and the like projecting from the switch body.

6.4.7 Flexible cord

6.4.7.1 Reinforced insulation is considered to exist inside an appliance where the jacket of a jacketed-type flexible cord contacts supplementary insulation.

6.4.7.2 Inside the appliance where the jacket has been removed, the insulated individual conductors of a jacketed-type flexible cord may be insulated from an accessible noncurrent-carrying metal part by supplementary insulation in any one of the following forms:

- a) An insulating liner;
- b) A coating of insulating material; or
- c) A sleeve around the cord, if the sleeve is loose fitting and is secured to the enclosure.

6.4.7.3 If one or more of the insulated individual conductors of the flexible cord contacts supplementary insulation inside the appliance, the conductor insulation and the supplementary insulation shall be such that they are not affected to the same degree by deteriorating influences such as heat, contaminants and the like. The flexible cord jacket itself may serve as the supplementary insulation for the insulated individual conductors if the jacket is of thermoplastic or thermoset material; and the conditions of use of the appliance are not likely to stress or degrade the physical properties of the jacket.

6.4.8 Internal wiring

6.4.8.1 Reinforced insulation is considered to exist at points inside of the appliance where the insulated wiring – including insulated splices – contacts supplementary insulation. See Clause [6.4.8.3](#).

6.4.8.2 Internal wiring that has basic insulation – including an insulated splice – shall be spaced at least 0.8 mm (1/32 in) from an accessible noncurrent-carrying metal part.

6.4.8.3 If internal wiring that has basic insulation – including an insulated splice – contacts an enclosure of insulating material, the insulation on the wire and the enclosure of the insulating material shall be such that they are not affected to the same degree by deteriorating influences such as heat and contaminants.

6.4.8.4 Insulating tubing may be accepted as supplementary insulation between internal wiring that has basic insulation – including an insulated splice – and accessible noncurrent-carrying metal, if all of the following conditions are met:

- a) The tubing shall be loose fitting on the conductors;
- b) The tubing shall be so fixed in position as to restrict relative movement between the tubing and the metal;
- c) The length of the leads shall reduce the likelihood of any tension during assembly or repair;
- d) The tubing shall not contact sharp bends, projections, corners or the like, nor shall it be subject to tension or compression;
- e) The wiring shall not be subject to flexing;
- f) The materials of the tubing and the insulation on the wire shall be such that they are not affected to the same degree by deteriorating influences such as heat and contaminants; and
- g) The tubing shall be of a thickness that is acceptable for the application.

6.5 Power supply cord

6.5.1 A power supply cord shall not include a grounding conductor.

6.5.2 Inside the appliance, the insulated individual conductors of a power supply cord shall not contact an accessible noncurrent-carrying metal part.

6.6 Strain relief

6.6.1 If an accessible metal strain-relief clamp is employed, it shall be provided with supplementary insulation located between the clamp and the flexible cord.

6.7 Bushings

6.7.1 A bushing of insulating material shall be provided at each point at which a flexible cord passes through a noncurrent-carrying metal part. A bushing of rubber, neoprene, polyvinyl chloride, or similar material shall not be used for this application.

6.8 Capacitors

6.8.1 The dielectric in a capacitor shall not be depended upon as supplementary insulation.

6.9 Extra-low voltage circuits

6.9.1 If an extra-low voltage circuit, see Clause [3.18](#), is conductively connected to an accessible noncurrent-carrying metal part, or terminal or outlet for connection of circuits external to the appliance, the circuit shall be considered to be accessible noncurrent-carrying metal.

6.10 Spacings

6.10.1 Spacings shall be in accordance with [Table 14](#).

6.11 Internal wiring

6.11.1 Internal wiring shall be located or restrained so that breakage or loosening of the wire at a termination and subsequent displacement cannot reduce the spacings to values below those specified in [Table 14](#).

Exception: If breakage or loosening of the wire at a termination and subsequent displacement causes malfunctioning of the appliance and does not result in a live part being made accessible, internal wiring need not be restrained or so located.

6.11.2 Compliance with Clause [6.11.1](#) can be accomplished by one or more of the following means:

- a) The use of barriers;
- b) Relative placement of parts;
- c) Physical restraint of the conductor in addition to that resulting from its intended electrical connections; or
- d) Other equivalent means.

6.11.3 The requirement specified in Clause [6.11.1](#) necessitates that a brush holder be constructed so that, upon removal of the brush cap, the spring cannot contact accessible noncurrent-carrying metal.

6.11.4 A supplementary part, such as an insulating barrier liner, that is necessary to maintain the level of insulation shall be so secured to the appliance that it remains in place when the power supply cord or a component, such as a switch, is being replaced.

Exception: A supplementary part need not be fixed to the appliance if its design precludes its being left out after servicing of the appliance.

6.12 Leakage-current test

6.12.1 The leakage current of a double insulated appliance when tested in accordance with Clause [5.3](#), leakage current, Clause [5.4](#), leakage-current following humidity conditioning, and Clause [8.5](#), leakage-current test, shall not be:

- a) More than 0.25 MIU for accessible noncurrent-carrying metal parts;
- b) More than 0.5 MIU for inaccessible noncurrent-carrying metal parts; and
- c) More than 0.5 MIU between accessible and inaccessible noncurrent-carrying metal parts.

6.12.2 Prior to the test described in Clause [6.12.1](#), an appliance having parts that are likely to produce conductive dust, such as the commutator and brush assembly of a universal motor, shall be operated for 100 h, or until the brushes wear out, whichever interval is shorter, but in no case less than 25 h. Brushes shall be replaced during this test if necessary to achieve 25 h of operation. Air inlets shall be unrestricted and motorized agitators (if provided) shall be unloaded.

6.12.3 The humidity chamber conditioned sample specified in leakage-current following humidity conditioning, Clause [5.4](#), may be used for several tests. The sequence of testing following humidity conditioning shall be:

- a) Leakage current;
- b) Insulation resistance (see Clause [6.14](#)); and
- c) Dielectric withstand.

6.12.4 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the resistors shall be shorted one at a time prior to the test.

6.13 Dielectric voltage-withstand test

6.13.1 For the tests specified in dielectric voltage-withstand, Clause [5.11](#), and dielectric voltage-withstand test, Clause [8.4](#), the points of application and the potentials employed shall be in accordance with [Table 15](#).

6.13.2 For an appliance employing discharge-path resistors as described in Clause [4.2.5.7](#), the connection shall be open-circuited at the point of attachment to the accessible part.

6.14 Insulation resistance

6.14.1 The appliance shall be conditioned as described in leakage-current following humidity conditioning, Clause [5.4](#). After conditioning, the appliance shall have an insulation resistance not less than the following:

- a) Between live parts and accessible noncurrent-carrying metal parts – 7 MΩ;
- b) Between live parts and inaccessible noncurrent-carrying metal parts – 2 MΩ; and
- c) Between inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts – 5 MΩ.

6.14.2 For an appliance having an outer enclosure consisting wholly or partly of insulating material, the term "accessible noncurrent-carrying metal parts" used in Clause [6.14.1](#) signifies metal foil tightly wrapped around the exterior of the enclosure.

6.14.3 If the appliance has parts that might produce conductive dust, the insulation resistance test shall be made on the sample conditioned in accordance with Clause [6.12.2](#). See also Clause [6.12.3](#).

6.14.4 The measurements of insulation resistance and the dielectric voltage-withstand test mentioned in Clause [6.14.6](#) shall be made with the appliance still in the humidity conditioning chamber.

6.14.5 In the determination of insulation resistance, a direct potential of 500 V shall be employed, and the value of insulation resistance shall be determined 1 min after application of the test potential. The sample shall not be energized during this test.

6.14.6 Following the insulation resistance test, and while still humidity conditioned, the sample shall be subjected to the dielectric voltage-withstand test in Clause [6.13](#).

6.15 Resistance to impact test

6.15.1 The appliance shall withstand the applicable impact tests specified in Clause [5.19](#) without making accessible to contact noncurrent-carrying metal parts that are insulated from live parts by basic insulation only, and basic insulation. The appliance shall comply with the dielectric voltage-withstand test in Clause [6.13](#) after being subjected to the impact test.

6.16 Abnormal operation test

6.16.1 Abnormal operation as specified in Clause [5.21.7](#) shall not affect the insulation to the extent that it does not comply with Clause [6.16.2](#) or that it exposes live parts. The tests specified in abnormal operation, Clause [5.21.7](#), shall be conducted on all double insulated appliances regardless of whether they employ thermoplastic or metal enclosures.

6.16.2 Following abnormal operation specified in Clause [6.16.1](#), the appliance shall be given time to cool to room temperature and shall withstand for 1 min without breakdown the application, between live parts and accessible noncurrent-carrying metal parts, or the foil described in note b of [Table 14](#) and [Figure 14](#), of the potential specified in [Table 15](#).

6.17 Overload test on motors

6.17.1 General

6.17.1.1 Operation of a motor under conditions of extreme overload shall not affect the appliance insulation to the extent that the insulation does not comply with Clause [6.17.4.3](#) or that live parts are exposed.

6.17.1.2 To determine whether a motor complies with Clause [6.17.1.1](#), three previously untested samples of the appliance shall be operated as described in Clause [6.17.2.1](#) for vacuum cleaners and blower cleaners or Clause [6.17.3.1](#) for household use floor finishing machines.

6.17.2 Vacuum cleaners and blower cleaners

6.17.2.1 Each of three samples of the motor shall be subjected to operation at rated load for 1 h. Immediately following this, the load shall be increased in steps of 10% of the rated current for each of four

successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min each as prove necessary to achieve breakdown of the basic insulation.

6.17.3 Household use floor finishing machines

6.17.3.1 Each of three samples of the complete product shall be subjected to operation at no load for 1/2 h, immediately followed by operation at full load for 1/2 h. Immediately following this, the load shall be increased in steps of 10% of the rated current for each of four successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min each as prove necessary to produce malfunction or breakdown of the basic insulation.

6.17.4 Test conditions

6.17.4.1 With reference to Clauses [6.17.2.1](#) and [6.17.3.1](#), breakdown of the basic insulation shall be considered to have occurred when flame appears or the winding burns open. If flame appears, the overload operation shall be terminated, and the flames extinguished.

6.17.4.2 During the running-overload operation described in Clause [6.17.2.1](#) or [6.17.3.1](#), any protective device provided with the motor shall be short-circuited, and the branch-circuit protection shall be of high enough capacity to withstand the test currents without opening the circuit. The objective of the test shall determine the integrity of the motor insulation and not the effectiveness of a protective device.

6.17.4.3 Following the operation described in Clause [6.17.2.1](#) or [6.17.3.1](#), the motor shall be given time to cool to room temperature and the appliance shall withstand for 1 min, without breakdown, the application of a 60-Hz potential of 1000 V plus twice the rated voltage between:

- a) Live parts and accessible noncurrent-carrying metal parts or the foil as mentioned in item 2 of [Table 15](#) and [Figure 14](#); and
- b) All inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts or the foil as mentioned in item 2 of [Table 15](#) and [Figure 14](#).

6.18 Investigation of armature employing reinforced insulation

6.18.1 If a motor construction includes reinforced armature insulation as mentioned in Clause [6.4.5.1\(c\)](#), each of three samples of the armature, after each of three conditioning procedures described in Clauses [6.18.2](#) – [6.18.4](#), shall withstand for 1 min, without breakdown, the application of a 60 Hz sinusoidal potential of 1000 V plus twice the rated voltage between the armature winding and the noncurrent-carrying metal that is separated from live parts by reinforced insulation.

6.18.2 The three samples mentioned in Clause [6.18.1](#) shall first be conditioned in an oven for 500 h at a temperature of 120°C (248°F) for a Class A system, 140°C (284°F) for a Class B system or 20°C (68°F) higher than the temperature rating of the insulation, if other than Class A or Class B.

6.18.3 One armature sample shall then be caused to carry the locked rotor current of the motor, another shall be caused to carry half of such locked rotor current, and the third shall be caused to carry one fourth of that locked rotor current. The specified current shall flow in each sample for 4 h unless breakdown of the basic insulation, as defined in Clause [6.17.4.1](#), occurs before the end of that interval. If breakdown of the basic insulation of a given sample does not occur before the end of the 4-h period, the test shall be continued as long as is necessary to accomplish that result, with the current during each additional hour being increased by 50% of the initial value.

6.18.4 Each sample shall then be rotated at its normal no-load speed for 1 min by any convenient external means.

6.19 Resistance to moisture test

6.19.1 As a result of the applicable tests mentioned in resistance to moisture, Clause [5.12](#), the appliance shall:

- a) Comply with the leakage-current test, Clause [6.12](#); and
- b) Withstand for 1 min, without breakdown, the application of a 60 Hz essentially sinusoidal potential of 2000 V plus twice the rated voltage of the appliance between live parts and accessible noncurrent-carrying metal parts, or the foil mentioned in note b to [Table 14](#) and [Figure 14](#).

6.20 Manufacturing and production tests

6.20.1 Production line dielectric voltage-withstand test

6.20.1.1 Each appliance marked as double insulated shall withstand for one second without electrical breakdown, as a routine production-line test, the application of the potentials indicated in [Table 16](#) in accordance with the test method described in dielectric voltage-withstand, Clause [10.1](#).

7 Rechargeable Battery-Powered Appliances

7.1 Products covered by this clause of the standard that are powered by rechargeable batteries either solely or as an alternative or in conjunction with other sources shall meet the requirements of UL 2595 / CSA C22.2 No. 0.23, with the conditions and specifications as required by Annex D of that standard as indicated in Clauses [7.2](#) – [7.16](#) below.

7.2 In reference to Indent A of Annex D of UL 2595 / CSA C22.2 No. 0.23, except as indicated elsewhere in UL 2595, the following requirements in this end product standard do not apply or are amended as indicated below:

- a) Clauses [6](#) (Double Insulation), [8](#) (Current-carrying hoses and accessory electrified wall valves), and [10](#) (Manufacturing and Production Tests) do not apply in their entirety.
- b) The Clauses specified in [Table 32](#) do not apply.
- c) The portions of Clause [5.12](#) that require the outcome of conditioning or testing to comply with dielectric voltage withstand and/or leakage current, and the wetting of any electrical components, shall instead consider increased risk of injury to persons, fire or shock for those areas where the voltages are in excess of the hazardous voltage; see Section 8 of UL 2595. In the application of Section 8 of UL 2595 / CSA C22.2 No. 0.23, a part that is wetted during the testing of Clause [5.12](#) is considered an accessible part.
- d) For Clause [5.12.2.3](#), the test is conducted as specified in Section 11.1 of UL 2595 / CSA C22.2 No. 0.23, rather than measuring the motor winding temperatures.
- e) Clause [5.21.10](#) is applied, but only in reference to the external temperatures recorded during the heating test of UL 2595 / CSA C22.2 No. 0.23.
- f) The Clauses referenced in (a) – (e) above would apply to those products also powered from mains or other non-isolated sources to the extent that requirement would apply to the risk of electric shock in the area of the product containing such a source.
- g) The testing of Clause [5.19](#) applies to the appliance, but the acceptance/compliance criteria of the mechanical strength test of UL 2595 / CSA C22.2 No. 0.23 shall be applied.

h) For Clauses [11.4.7](#), [11.4.18](#), [11.4.19](#), [12.2](#), and [Table 18](#), the marking or instruction requirements that pertain to the risk of electric shock only apply to products operating at hazardous voltages. Items related to the risk of fire or explosion (e.g., items 14, 15, and 16 of [Table 18](#)) shall apply as indicated.

i) For Clauses [11.4.14](#) and [11.4.15](#), the statement "Unplug Before Cleaning or Servicing" shall be replaced with "Disconnect Battery Pack Before Cleaning or Servicing", or the equivalent.

7.3 With respect to Indent B of Annex D of UL 2595 / CSA C22.2 No. 0.23, users are not considered to be wet during the use of these products except for wet pick up and extractor type appliances.

7.4 With respect to Indent C of Annex D of UL 2595 / CSA C22.2 No. 0.23, LT specification is required for batteries for products not marked intended for indoor use; see [Table 18](#) of this end product standard, and ELT: -35°C specification for products not marked "Use Indoors" or "Store Indoors".

7.5 With respect to Indent D of Annex D of UL 2595 / CSA C22.2 No. 0.23, during the heating test, portable vacuum cleaners shall be operated without detachable hoses and attachments and with no additional restriction on the intake of air.

7.6 With respect to Indent E of Annex D of UL 2595 / CSA C22.2 No. 0.23, the temperature limits listed in Table 9.1 of UL 2595 are considered suitable.

7.7 With respect to Indent F of Annex D of UL 2595 / CSA C22.2 No. 0.23, during the abnormal tests of the of Annex D of UL 2595, the appliance shall be operated with the intake ports uncovered and with no additional mechanical load for those tests where applicable.

7.8 With respect to Indent G of Annex D of UL 2595 / CSA C22.2 No. 0.23, additional or alternative safety-critical functions (SCFs) are identified in [Table 30](#) of this end product standard.

7.9 With respect to Indent H of Annex D of UL 2595 / CSA C22.2 No. 0.23, the impact surface may be conducted on hardwood or concrete.

7.10 With respect to Indent I of Annex D of UL 2595 / CSA C22.2 No. 0.23, products covered by this end-product standard are not required to have this special switching arrangement.

7.11 With respect to Indent J of Annex D of UL 2595 / CSA C22.2 No. 0.23, battery-operated appliances that can also be operated or charged by mains or a non-isolated sources as described in UL 2595, shall also meet the requirements of this end-product standard that apply to the risk of electric shock. For these types of appliances, the exempted requirements specified in Clause [7.2\(b\)](#) of this end-product standard might be applicable.

7.12 The requirements in Clauses [7.13](#) – [7.17](#) of this end-product standard additionally apply to automatic battery-powered vacuum cleaners (e.g., robot vacuums and their docking stations).

7.13 In the application of UL 2595 / CSA C22.2 No. 0.23, Section 6.7, an automatic battery-powered vacuum cleaner shall be marked "For use only with ____ docking station," or the equivalent. The docking station may be identified by a catalog number, series identification, or the equivalent. Alternatively, the statement "See Instruction Manual for Additional Docking Stations," or the equivalent, may be employed in addition to at least one docking station referenced by catalog number.

7.14 With respect to Indent A of Annex D of UL 2595 / CSA C22.2 No. 0.23, in the application of Clauses [12.2.6](#) and [12.2.7](#) of this end-product standard, an automatic battery-powered vacuum cleaner shall also be provided with the following cautionary instructions or the equivalent regarding proper room preparation before using the appliance:

- a) Place the cords from other appliances out of the area to be cleaned.
- b) Do not operate the vacuum in a room where an infant or child is sleeping.
- c) Do not operate the vacuum in an area where there are lit candles or fragile objects on the floor to be cleaned.
- d) Do not operate the vacuum in a room that has lit candles on furniture that the vacuum may accidentally hit or bump into.
- e) Do not allow children to sit on the vacuum.
- f) Do not use the vacuum on a wet surface.

7.15 With respect to Indent D of Annex D of UL 2595 / CSA C22.2 No. 0.23, during the heating test, automatic battery-powered vacuum cleaners shall be operated on the test carpet described in Clause [5.2.1.2](#) of this end-product standard. A border or frame measuring 1.5 m by 1.5 m (5-ft by 5-ft) shall be used on the carpet to the limit the area of operation. The air inlet shall be unobstructed.

7.16 With respect to Indent G of Annex D of UL 2595 / CSA C22.2 No. 0.23, additional safety-critical functions (SCFs) for automatic battery-powered vacuum cleaners are in [Table 31](#) of this end-product standard.

7.17 With respect to Indent H of Annex D of UL 2595 / CSA C22.2 No. 0.23, the robot vacuum part of an automatic rechargeable battery-powered vacuum cleaner shall be subjected to an evenly distributed load of 60 kg (130-lbs) placed on top of the vacuum for a period of one minute. This test shall be conducted on three samples of the vacuum. As a result of the testing, no short circuit shall occur, and there shall not be any condition that would increase the risk of fire or personal injury resulting from operation of the appliance.

8 Current-carrying hoses and accessory electrified wall valves

8.1 Scope

8.1.1 These requirements cover:

- a) Current-carrying hoses for use with vacuum cleaner/motorized nozzle combination appliances intended for household, dry pick-up, indoor use;
- b) Current-carrying hoses for use with motorized nozzles intended for use with central vacuum cleaning systems intended for household, dry pick-up, indoor use;
- c) Wet pick-up current-carrying hoses for use with household, indoor use carpet cleaning equipment;
- d) Grounded current-carrying hoses for use with motorized nozzles intended for household indoor use; and
- e) Electrified wall valves for connection of current-carrying hose/motorized nozzle combinations for central vacuum cleaning systems intended for household use.

8.1.2 These requirements supplement those in Clauses [1](#) – [6](#) and Clause [11](#) of this Standard.

8.2 Construction – General

8.2.1 A current-carrying hose, as covered by these requirements, consists of individually insulated copper, copper-clad steel, or steel-reinforced copper conductors that are additionally insulated by the hose structure. The conductors may be used for structural support of the hose.

Exception: The grounding conductor need not be individually insulated if separated from current carrying conductors by minimum 0.78 mm (1/32 in) thickness of the hose structure insulation (see Clause [8.17](#)).

8.2.2 The grounding conductor shall be at least same size and material or have conductivity equal to or greater than the conductivity as the current-carrying conductors.

8.2.3 An electrified wall valve for a central vacuum cleaning system intended for the connection of a current-carrying hose/motorized nozzle combination shall be configured as shown in [Figure 21](#). See Clause [8.2.6](#). In addition, the wall-valve assembly shall comply with the applicable requirements in the following standards:

- a) C22.2 No. 18.1 and UL 514A;
- b) C22.2 No. 18.2 and UL 514C; and
- c) C22.2 No. 42.1 and UL 514D.

8.2.4 The configuration of the field wiring leads to the connector of a wall-valve assembly shall be as shown in [Figure 22](#).

8.2.5 The end fitting of a current-carrying hose intended for connection to a central vacuum cleaner wall valve, employing direct supply connections for electrical accessories, shall be configured as shown in [Figure 23](#). See Clause [8.2.6](#).

8.2.6 A current-carrying hose/electrified wall-valve combination employing a configuration other than that specified in Clauses [8.2.3](#) and [8.2.5](#) shall have the hose and wall valve marked in accordance with Clauses [8.18.6](#), [12.5.13](#), and the Exception to Clause [12.5.15](#).

8.2.7 All accessible noncurrent-carrying metal parts of a central vacuum cleaner's electrified wall valve assembly (outlet assembly) that are likely to be energized shall be connected to the equipment grounding conductor or equipment grounding terminal of the valve assembly. Parts that are not considered likely to be energized are metal screws or rivets in polymeric enclosures or faceplates, external metal springs used on a self-closing polymeric cover, and the like. Electrified wall valves connected to an extra-low voltage circuit are excluded from this requirement.

8.2.8 An attachment plug used on a current-carrying hose end fitting in which the orientation of the parallel blades can be rotated by the user, shall be provided with the means to prevent unintentional rotation and shall be subjected to the Endurance Test, Clause [8.16](#).

8.2.9 A grounded type current-carrying hose optionally protected by overcurrent devices provided in the appliance for purpose of the test specified in Clause [8.17.2\(b\)](#) shall have the protector located in the ungrounded current carrying conductor.

8.2.10 Current-carrying hoses with a minimum 22 AWG (0.33 mm²) high-voltage conductor and a length equal to or greater than 3 m (10 ft) shall be provided with a 7 A fuse in the live conductor.

Exception: The Limited overcurrent test of Clause [8.10](#) may be performed in lieu of adding the fuse.

8.3 Tests – General

8.3.1 Unless otherwise specified, each sample that is subjected to the tests described in Clauses [8.4](#) – [8.16](#) shall be of the length intended for normal use.

8.4 Dielectric voltage-withstand test

8.4.1 A current-carrying hose shall withstand without breakdown for 1 min the application of a 60 Hz essentially sinusoidal potential as described in the dielectric voltage-withstand test, Clause [5.11](#) when tested in accordance with Clauses [8.4.2](#) or [8.4.3](#), and [8.4.4](#).

8.4.2 A sample of a dry pick-up hose, including the complete end fittings, shall be tested in the as-received condition. The sample shall be suspended in a vertical position with 0.61 m (2 ft) of the hose and the complete end fitting placed into a container. The container and the inside of the hose section that is within the container shall be filled with No. 7-1/2 conductive shot, except that, if agreeable to those concerned, smaller shot may be used. For the purpose of this test, an uninsulated live part, such as a pin terminal, used to facilitate a user separable connection shall be insulated. Additionally, any opening in a hose end fitting that complies with accessibility to live parts, Clause [4.2.5](#), may be sealed.

8.4.3 A sample of a wet pick-up current-carrying hose shall be tested while immersed in a solution consisting of 0.5 g of sodium chloride per liter of distilled water. All the air shall be displaced by the solution from the interior of the hose during the immersion.

Exception: The external portion of the vacuum cleaner connector end may be tested using the conductive shot specified in Clause [8.4.2](#).

8.4.4 After preparation as described in Clause [8.4.2](#) or [8.4.3](#), the potential shall be applied between current-carrying conductors of opposite polarity, and between current-carrying conductors and the conductive shot or solution. The test shall be conducted on each end of the sample if different end fittings are employed.

8.4.5 For a current-carrying hose with integral grounding conductor, the potential shall also be applied between each current-carrying conductor and the grounding conductor.

8.5 Leakage-current test

8.5.1 The leakage current of a current-carrying hose, when tested as described in Clause [8.5.2](#), shall not be more than 0.5 mA.

8.5.2 A sample of the current-carrying hose assembly shall be tested in the as-received condition. The sample shall be prepared as described in Clause [8.4.2](#) or [8.4.3](#), as applicable. The leakage current shall be measured from the conductive shot for a dry pick-up hose, and from the solution for a wet pick-up hose. The test method shall be as specified for leakage-current, Clause [5.3](#), and leakage-current after humidity conditioning, Clause [5.4](#).

8.6 Oven conditioning test

8.6.1 After being conditioned as described in Clause [8.6.2](#), the insulation of a current-carrying hose shall not show excessive deterioration – for example, cracking, flaking, or softening – and shall comply with the dielectric voltage-withstand test specified in Clause [8.4.1](#).

8.6.2 Three samples of the complete current-carrying hose assembly shall be conditioned for 7 h in an air-circulating oven at 70°C (158°F). After being removed from the oven, the samples shall be examined

for deterioration. For the purpose of this test, discoloration of the hose material shall not be considered deterioration.

8.6.3 Additional samples to be conditioned as described in Clause [8.6.2](#) prior to further testing shall remain at normal room temperature for a minimum of 24 h after removal from the oven before such tests are conducted.

8.7 Voltage drop test

8.7.1 The voltage drop across a current-carrying hose shall not exceed 6% of the rated voltage when the hose is tested as described in Clause [8.7.2](#).

Exception No. 1: The voltage drop may exceed 6% if it is determined in the end-use application that such a drop does not have an adverse effect on the motorized nozzle connected to the hose.

Exception No. 2: The test is not carried out on current-carrying hoses having a minimum 22 AWG (0.33 mm²) conductor size.

8.7.2 The hose shall be connected to a 60 Hz supply circuit that causes it to carry rated current. This condition shall continue until temperatures stabilize, at which time the maximum voltage drop across both conductors shall be measured.

8.8 Temperature test

8.8.1 A current-carrying hose shall be tested as described in Clause [8.8.2](#). During the test:

- a) The temperature rise of the insulation material (see Clause [8.2](#)) shall not exceed 35°C (63°F) at any point; and
- b) No other material or component part shall exceed the temperature rises specified in [Table 9](#).

8.8.2 The hose shall be placed on a softwood surface and shall be connected to a 60 Hz supply circuit that causes the hose to carry rated current. The test shall be continued until constant temperatures are reached. Temperatures shall be measured using thermocouples.

8.9 Overload test

8.9.1 Two samples of the hose, one in the as-received condition and one subjected to the oven conditioning specified in Clause [8.6](#), shall be tested as described in Clause [8.9.2](#). During the test, there shall be no evidence of a risk of fire and, upon completion of the test, the hose shall comply with the dielectric voltage-withstand test, Clause [8.4](#). If, after the procedure described in Clause [8.9.2](#), sections of the hose exhibit more deterioration than the sections being subjected to dielectric testing, then a 0.61-m (2-ft) long sample of the more deteriorated section or sections of the hose shall also be subjected to the dielectric voltage-withstand test, Clause [8.4](#).

8.9.2 The hose shall be placed on a softwood surface that is covered by a single layer of white tissue paper. It shall be connected to a circuit that causes the hose to carry rated locked-rotor current continuously for 7 h.

8.10 Limited overcurrent test

8.10.1 A current-carrying hose shall be tested as described in Clauses [8.10.2](#) – [8.10.5](#). During the test, there shall be no evidence of a risk of fire, and, upon completion of the test, there shall be no exposure of current-carrying parts.

8.10.2 Three samples of a current-carrying hose in the as-received condition shall be tested. Each sample shall be placed on a softwood surface that is covered by a single layer of white tissue paper and draped with a single layer of cheesecloth. For a hose that is less than 4.6-m (15-ft) long, the hose shall be tested in a straight configuration. For a hose that is 4.6 m (15 ft) or longer:

- a) Two-thirds of the hose at the end intended for connection to the test circuit shall be in a coiled configuration having a 0.5-m (1.6-ft) inner diameter of the coil; and
- b) One-third of the hose at the end intended for connection to the power nozzle shall be in a straight configuration.

8.10.3 The conductors at the end of the hose intended for connection to the power nozzle shall be externally connected together. The other end of the hose shall be connected in series with 18 AWG (0.82 mm²) Type SVT cord to a 120 V, 60 Hz test circuit with a power factor of 0.9 to 1.0. Without the hose in the circuit, the circuit shall have a short-circuit capacity of 200 A. The length of the cord shall be 5.5 m (18 ft) for a hose intended for use with a portable appliance, or 1.8 m (6 ft) for a hose intended to be connected directly to the source of electrical supply. The hose may be connected in parallel with a load representing a vacuum cleaner of the minimum rating intended to be used with the hose assembly.

8.10.4 A 76-mm (3-in) long, 99.9% silver, 0.53-mm (0.02-in) diameter wire employed as described in Clause 8.10.5, or the fuse provided in the appliance, shall be connected in series with the hose under test. If there is no evidence of a risk of fire, the test shall continue until the series silver wire opens at least one inch from either terminal to which it is connected, the appliance fuse opens, or for a period of 7 h, whichever occurs first.

8.10.5 The silver wire mentioned in Clause 8.10.2 shall be placed horizontally along the center line of a box with approximate inside dimensions of 89-mm (3-1/2-in) long, 45-mm (1-3/4-in) wide, and 76-mm (3-in) high. Two wiring terminals shall be spaced 76-mm (3-in) apart inside the box, and one end of the silver wire shall be connected to each terminal so that the wire measures 3 in from terminal to terminal. The silver wire shall be connected to the hose under test with 12 AWG (3.3 mm²) copper wire connected through wireways (small openings or holes) in the sides of the box.

8.11 Crushing test

8.11.1 A current-carrying hose shall be subjected to a crushing force of 2,224 N (500 lb) as described in Clause 8.11.2. While the force is maintained at 2,224 N (500 lb), the hose shall withstand for 1 min without breakdown the application of a 60 Hz essentially sinusoidal potential as specified in the dielectric voltage-withstand test, Clause 5.11. Following the test, there shall be no exposure of any uninsulated live parts.

8.11.2 A current-carrying hose in the as-received condition and one that has been conditioned as described in oven conditioning test, Clause 8.6, shall be tested. Each sample shall not be less than 203-mm (8-in) long. The hose shall be:

- a) Placed between two 102- by 102-mm (4- by 4-in), 12.7-mm (1/2-in) thick steel plates with a 1.6-mm (1/16-in) radius at the edges; and
- b) Positioned so that its major axis is perpendicular to two opposite edges of the steel plates.

8.11.3 The sample and the plates shall then be placed in a testing machine that will decrease the distance between the plates at a rate of not more than 12.7 mm/min (1/2 in/min). The crushing force shall be applied until a force of 2224 N (500 lbs) is reached. The dielectric potential shall then be applied between:

- a) Each current-carrying conductor;
- b) The current-carrying conductors and the steel plates; and

- c) The current-carrying conductors and any noncurrent-carrying metal provided.

8.12 Thermal shock test

8.12.1 After being conditioned as described in Clause [8.12.3](#), a current-carrying hose shall comply with the dielectric voltage-withstand requirement in Clause [8.4.1](#).

8.12.2 A current-carrying hose in the as-received condition and one that has been conditioned as described in oven conditioning test, Clause [8.6](#), shall be tested. Each sample shall be 61.0-cm (24-in) long and shall be subjected to a total of 10 cycles of conditioning described in Clause [8.12.3](#).

8.12.3 Each sample shall be bent to form the shape shown in [Figure 15](#), and shall be secured at a distance of 25 mm (1 in) from each end. The hose shall be conditioned for 3 h in an air-circulating oven at a temperature of 65°C (149°F). Immediately after being removed from the oven, the sample shall be conditioned for 3 h at a temperature of minus 20°C (minus 4°F). Between 15 – 20 s after removal from the freezer, the hose shall be flexed three times, as illustrated in [Figure 16](#), at a rate of one flex per second. To complete a cycle of conditioning, the sample shall be returned to room temperature.

8.13 Flexing test

8.13.1 Vertical

8.13.1.1 A current-carrying hose in the as-received condition and one that has been conditioned as described in oven conditioning test, Clause [8.6](#), shall be tested as described in Clauses [8.13.1.3](#) and [8.13.1.4](#). Each sample shall be 1.2-m (4-ft) long, exclusive of the attached end fitting or cuff. Following the test:

- a) The conductors in each sample shall be unbroken and undamaged as demonstrated by energizing the hose so that rated current flows for 1 min;
- b) Each sample shall comply with the dielectric voltage-withstand test, Clause [8.4](#);
- c) The end fitting shall not separate from the hose; and
- d) No sample shall have an increase of more than 10% in electrical resistance of the hose assembly.

8.13.1.2 The test described in Clauses [8.13.1.3](#) and [8.13.1.4](#) shall be repeated on additional samples employing the opposite end fitting if it is of a different construction from the one tested.

8.13.1.3 The end fitting or cuff shall be mounted to the test apparatus illustrated in [Figure 17](#). A weight of 4.98 kg (11 lbs) shall be attached to the free end. To avoid swaying of the weight, an adjustable deflection plate shall be employed. Initially, the height of the test fixture shall be adjusted so that at the bottom of the stroke, the weight just comes to rest on the supporting plate. No further adjustment to the height shall be made unless the weight is not lifted from the supporting plate at any time during a cycle. At that time, the height shall be readjusted as described for initial adjustment. The hose end fitting shall be mounted on the pivot arm so that the point where the hose enters the end fitting is 305 mm (12 in) from the arm pivot point.

8.13.1.4 Each cycle of operation shall consist of rotating the fixture arm upward 40° and returning it to the horizontal. The test apparatus shall be operated for 2500 cycles at a rate of 10 cycles per minute. The fixed end shall then be rotated 90° and operated for an additional 2500 cycles. This procedure shall be repeated two additional times, rotating the fitting an additional 90° each time, for a total of 10,000 cycles.

8.13.2 Horizontal

8.13.2.1 A current-carrying hose in the as-received condition and one that has been conditioned as described in oven conditioning test, Clause [8.6](#), shall be tested as described in Clause [8.13.2.2](#). Each sample shall be 1.2-m (4-ft) long, exclusive of the attached end fitting or cuff. Following the test:

- a) The conductors in each sample shall be unbroken and undamaged as demonstrated by energizing the hose so that rated current flows for 1 min;
- b) Each sample shall comply with dielectric voltage-withstand test, Clause [8.4](#); and
- c) No sample shall have an increase of more than 10% in electrical resistance of the hose assembly.

8.13.2.2 The hose shall be secured at one end to a test apparatus that will provide a horizontal reciprocating motion having a total travel of 305 ± 6.4 mm ($12 \pm 1/4$ in). The reciprocating motion shall be generated through a 610-mm (24-in) long connecting rod that is moved in a sinusoidal motion by a 152-mm (6-in) long driving arm rotating at 36 ± 1 revolutions per minute. See [Figure 18](#). The hose shall be placed over a pulley, illustrated in [Figure 19](#). The pulley side walls may be increased to any convenient diameter necessary to hold the hose to the center line. The free end shall be attached to a 4.54 ± 0.03 kg ($10 \text{ lb} \pm 1 \text{ oz}$) weight. With the weight guided to prevent swinging, the test shall be conducted for 20,000 cycles – one cycle consisting of one forward and one reverse movement of the reciprocating apparatus.

8.14 Abrasion test

8.14.1 General

8.14.1.1 A current-carrying hose shall be tested as described in Clauses [8.14.2](#) and [8.14.3](#) without exposing a current-carrying part, as determined by visual examination and by compliance, after testing, with the dielectric voltage-withstand test, Clause [8.4](#).

8.14.2 External

8.14.2.1 A 0.61-m (2-ft) long sample that includes the section passed over the emery cloth surface as specified in Clause [8.14.2.2](#) shall be used for the dielectric voltage-withstand test.

8.14.2.2 One sample, 1.2-m (4-ft) long, of a current-carrying hose in the as-received condition and one sample of the same length that has been conditioned as described in oven conditioning test, Clause [8.6](#), shall be tested. The samples shall be passed over a 51 – 76-mm (2 – 3-in) wide piece of emery cloth as described in Clause [8.14.2.3](#). The emery cloth shall be supported by the 90° arc of a cylinder having a 191-mm (7-1/2-in) radius. With one end of the hose secured to the reciprocating apparatus described in Clause [8.13.2.2](#), and with the free end of the hose attached to a 1.13 kg (2-1/2 lb) weight, the hose shall be positioned so that the midpoint of the hose is at the center of the emery cloth at the middle of the cycle. With the weight guided to prevent swinging, the hose shall pass over the emery cloth surface for 350 cycles – one cycle consisting of one forward and one reverse movement of the reciprocating apparatus.

8.14.2.3 The emery cloth mentioned in Clause [8.14.2.2](#) shall be No. 120 grit and shall be an aluminum oxide abrasive. The emery cloth shall have a cloth backing and an enclosed type of coating.

8.14.3 Internal

8.14.3.1 The entire length of the hose shall be subjected to the dielectric voltage-withstand test by testing a series of 0.61-m (2-ft) long segments.

8.14.3.2 One 1.2-m (4-ft) long sample of a current-carrying hose in the as-received condition and one sample of the same length that has been conditioned as described in oven conditioning test, Clause [8.6](#) shall be tested. Each sample shall be provided with fittings for connection to the power nozzle and vacuum cleaner so that normal suction is provided. The hose shall lie in a horizontal plane and the midpoint of the hose shall be formed around a 90° arc of a cylinder having a 10-in (254-mm) radius. The air flow through the hose shall be maintained at 1.4 m³ (50 ft³) per minute; a faster air flow rate may be used if agreeable to those concerned. The vacuum cleaner shall be energized and the hose is to pick up 45.4 kg (100 lbs) of previously unused 50 – 70 core silica sand at a rate of 2.3 kg (5 lbs) per minute. Each sample shall pick up the sand five times so that a total of 227 kg (500 lbs) of sand is picked up.

8.15 Wet pick-up

8.15.1 General

8.15.1.1 A current-carrying hose that is to be used as a component in a designated model of a household carpet cleaning appliance intended by the manufacturer for wet pick-up shall comply with the requirements for double-insulation specified in Clause [6](#).

8.15.1.2 For the purposes of these requirements, the interior surface of a wet pick-up current-carrying hose shall be considered accessible.

8.15.2 Immersion test

8.15.2.1 Two samples of a complete wet pick-up current-carrying hose, including end-fittings, shall be subjected to the immersion conditioning and tests specified in Clause [8.15.2.2](#). One sample shall be in the as-received condition; and one sample shall be conditioned in an air-circulating oven for 7 h at 70°C (158°F).

8.15.2.2 The samples described in Clause [8.15.2.1](#) shall be immersed for 7 days at 70°C (158°F) in the test solution supplied or recommended by the manufacturer, and mixed according to the manufacturer's recommendations. All the air shall be displaced by the solution from the interior of the hose during the immersion. After conditioning, each hose sample shall be subjected to the dielectric voltage-withstand test specified in Clause [8.4.3](#), and the thermal-shock test, Clause [8.12](#).

8.16 Endurance test

8.16.1 The attachment plug described in Clause [8.2.8](#) shall be capable of withstanding 100 cycles of rotation without resulting in:

- a) Damage to the terminals or internal wiring;
- b) Damage to the enclosure;
- c) Reduction of spacings;
- d) Access to current-carrying parts; or
- e) A risk of fire or electric shock.

8.16.2 Each of six representative units of a rotating type plug-in appliance shall be subjected to the required cycling at a minimum rate of 10 cycles per minute while unenergized. The units shall be rotated as intended in normal use. Following the required cycling, the units shall be examined and subjected to the applicable Dielectric Voltage-Withstand Test.

8.17 Grounded hose tests

8.17.1 The grounding conductor and grounding connections shall not open, and the voltage drop between the appliance main grounding terminal and the end of the hose shall not exceed 4 V when the ground path is tested as described in Clause [8.17.2](#).

8.17.2 The ground path mentioned in Clause [8.17.1](#) shall carry for 2 min a 60 Hz current as specified in items (a) or (b), whichever is lower:

- a) Twice the rating for the appliance; or
- b) Twice the rating of the overcurrent protective device provided in the hose.

8.17.3 Three as-received samples of grounded type current-carrying hose shall be additionally tested in accordance with Clause [8.10](#), having the grounding and one current-carrying conductor externally connected together at the end.

8.18 Marking

8.18.1 A current-carrying hose shall be permanently marked with the statement: "This Hose Contains Electrical Wires," or the equivalent. This marking shall be in letters not less than 2.4-mm (3/32-in) high, and visible either during assembly to the appliance or while in use.

8.18.2 A current-carrying hose as described in Clause [8.2.5](#) shall be permanently marked on the end-fitting intended for connection to the wall valve with the following: "Connect Only to a Type A Wall Valve."

8.18.3 A wall valve as described in Clause [8.2.3](#) shall be permanently marked where visible after installation with the following: "Central Vacuum Cleaning System Wall Valve – Type A."

8.18.4 A wall valve shall be marked and rated with an electrical rating of 120 V, 60 Hz, 7 A.

8.18.5 A wall valve shall be marked "For Household Use Only" or the equivalent.

8.18.6 A current-carrying hose/electrified wall-valve combination as described in Clause [8.2.6](#) shall be marked with the word "WARNING" and the following or the equivalent:

- a) On the wall valve: "To reduce the risk of electric shock connect only (hose manufacturer's name) electric hose, Cat. No. ___ to this wall valve."; and
- b) On the hose: "To reduce the risk of electric shock, connect only to (valve manufacturer's name) electrified wall valve, Cat. No. ___."

8.19 Marking

Section 8.19 deleted

8.19.1 Deleted

8.19.2 Deleted

8.19.3 Deleted

8.19.4 Deleted

8.19.5 Deleted

8.19.6 Deleted

9 Appliances Generating Ultraviolet (UV) Radiation

9.1 General

9.1.1 Appliances that generate ultraviolet radiation shall comply with the applicable requirements of this standard as well as the requirements in [9.2](#) – [9.6](#).

9.1.2 Appliances generating ultraviolet radiation are intended for use in accordance with the Code of Federal Regulations, CFR 21, Part 1040, Chapter 1, Subchapter J.

9.2 Construction

9.2.1 Polymeric enclosure and insulating materials, internal wiring, and other polymeric component parts shall be acceptably resistant to degradation when exposed to ultraviolet light, if degradation of the part would result in non-compliance with other requirements of this standard. To determine whether a part is acceptably resistant to ultraviolet light, the part shall be subjected to the Ultraviolet Light Exposure Test specified in C22.2 No. 0.17 and UL 746C.

Exception: A polymeric material that complies with the Ultraviolet Light Exposure Test requirements in the thickness and color used in the end-use appliance is considered to comply.

9.2.2 With reference to Clause [9.2.1](#) and C22.2 No. 0.17 and UL 746C, the material properties to evaluate the parts shall be as follows:

- a) A polymeric enclosure shall be subjected to flammability classification, tensile or flexural strength, and impact testing;
- b) A polymeric internal component part shall be subjected to flammability classification. If the part provides functional support it shall also be subjected to tensile or flexural strength.

9.3 Protection against injury to persons

9.3.1 Protection from overexposure to ultraviolet radiation

9.3.1.1 Equipment shall be investigated for emission of ultraviolet radiation in accordance with the ultraviolet irradiance test, Clause [9.4.1](#). Equipment that produces less than $0.1 \mu\text{W}/\text{cm}^2$ is not considered to present a risk of overexposure to ultraviolet radiation.

Exception: Equipment exclusively identified for the use of lamps rated "Exempt Risk Group" by ANSI/IESNA RP-27.1, are considered to comply with this requirement without test.

9.3.1.2 Equipment that emits more than $0.1 \mu\text{W}/\text{cm}^2$ and that is accessed by other than qualified personnel shall have features to minimize the risk of overexposure of users. User access to ultraviolet radiation that could result in overexposure shall be prevented by reliable means, such as enclosures and interlocks. See Clause [9.3.1.6](#).

9.3.1.3 Equipment that emits more than $0.1 \mu\text{W}/\text{cm}^2$ shall be specified for use locations where access to the equipment and the radiated emissions shall be restricted to qualified personnel. Product markings and instructions shall identify the protective equipment and the necessary precautions to minimize the risk of overexposure. See Clauses [9.5](#) and [9.6](#) for the required markings and instructions.

Exception: Equipment emitting radiation above $0.1 \mu\text{W}/\text{cm}^2$ in user accessible lamp compartments during relamping is acceptable if the product cannot be operated continuously with the lamp compartment opened and the product is marked in accordance with Clause [9.5.3](#).

9.3.1.4 Equipment that emits more than $0.1 \mu\text{W}/\text{cm}^2$ shall be provided with a user-actuated ON/OFF switch or control to activate and deactivate the ultraviolet function of the appliance.

9.3.1.5 Equipment that emits more than $0.1 \mu\text{W}/\text{cm}^2$ shall be provided with a visible and/or audible means to signal when the equipment is energized. If a visible indicating means is used, it shall be visible while approaching the equipment from any direction.

Exception: Equipment employing a momentary contact switch that energizes the ultraviolet radiation is considered to comply with this requirement.

9.3.1.6 Interlocks or interlock systems used to minimize risk of overexposure to ultraviolet radiation shall be reliable and comply with Clauses [4.20.7.9](#) – [4.20.7.12](#) and Clauses [9.3.1.7](#) – [9.3.1.10](#).

9.3.1.7 The actuator of an interlock shall be located so that unintentional operation is unlikely and the actuator cannot be defeated with the articulated probe.

9.3.1.8 With reference to Clause [9.3.1.6](#), interlocks or interlock systems used on household-use appliances shall be suitable for a minimum of 100,000 cycles of operation, and commercial-use appliances shall be suitable for a minimum of 200,000 cycles of operation. The applicable endurance testing shall be conducted with the interlock or interlock system controlling its normal load; see Clause [5.2](#).

9.3.1.9 During and after the applicable endurance test, the interlock or interlock system shall remain functional and any spring mechanism shall remain resilient so it may not be readily defeated. For example, the interlock shall not actuate when the appliance is overturned (the weight of the interlock itself including the roller mechanism, etc., shall not depress and engage the switch in the ON position because there is not enough spring retention).

9.3.1.10 Electronic controls used as part of the interlock or interlock system shall comply with the requirements of Clause [4.11.4](#).

9.3.2 Protection from ozone emissions

9.3.2.1 A household use appliance using a UV lamp operating at wavelengths less than or equal to 250 nm is considered to produce ozone during its normal operation and shall be tested in accordance with Clause [9.4.2](#).

9.3.3 Glass covers and guards

9.3.3.1 Glass covers and guards shall be a non-shattering or tempered type that, when broken, comply with the requirements in Clause [9.4.3](#).

9.3.3.2 Glass covers and guards that also provide protection against risk of electric shock shall comply with the applicable impact test described in Clause [5.19.2](#) or [5.19.3](#).

9.4 Performance

9.4.1 Ultraviolet irradiance test

9.4.1.1 Emissions of ultraviolet radiation from the equipment shall be evaluated in accordance with the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values and Biological Indices.

9.4.1.2 Testing shall be performed in the condition(s) most likely to result in the highest emission levels, including removal or adjustment of guards or operating settings. The test shall be performed using a new lamp (or other integral radiation source) representative of the maximum emission capability (including user replacement parts). The measurement device shall be placed as close as possible to the radiation source to represent the user's body.

9.4.1.3 For products that employ enclosures, guards, and similar protective features to minimize the risk of overexposure to ultraviolet radiation, these parts shall be resistant to degradation from mechanical abuse, including degradation from operation under severe conditions and abnormal conditions. After subjecting the protective features to the applicable tests of Clause 5.19 (5.19.2 or 5.19.3, 5.19.4, 5.19.5) and Clause 5.21 (5.21.3, 5.21.4, 5.21.5, 5.21.7, 5.21.9), the protective features shall be visually examined. If visual examination indicates that the protection afforded by the protective feature could have been impaired, ultraviolet irradiance measurements shall be repeated. In this case, a different sample shall be used for each mechanical abuse/irradiance test sequence unless it is agreeable to all parties to use the same sample for all required testing.

9.4.1.4 For equipment that can emit different levels of ultraviolet radiation under use and service conditions, both conditions shall be considered in the ultraviolet irradiance measurements.

9.4.1.5 Instrumentation used for the ultraviolet radiation measurements shall be suitable for the measuring emissions of the radiation source and wavelengths. Care shall be taken to ensure proper selection of instrumentation.

9.4.2 Ozone emissions

9.4.2.1 Chamber specifications

9.4.2.1.1 The test chamber construction materials, air tightness, and air mixing efficiency shall be as specified in ISO 16000-9.

9.4.2.1.2 The test chamber operating parameters, such as the loading factor, air supply system, ozone half-life, air exchange rate, temperature, and relative humidity, shall be as specified in ISO 28360.

9.4.2.2 Equipment specifications

9.4.2.2.1 Ozone analysis equipment shall meet the following criteria in items (a) – (d) below. To prevent loss of ozone in the sampling line, it shall be of minimum length, not exceeding 4 m (13.1 ft), and made of a flexible inert material such as PTFE:

- a) Ranges of 0.02, 0.04, 0.1, 0.2, and 0.4 mg/m³ on the full scale (or have auto ranging capability);
- b) The capability to detect 4 µg/m³ or lower concentration;
- c) A precision of ±2% from the mean value in the 0 mg/m³ to 0.2 mg/m³ range (i.e. 2 µg/m³ or 1% on the full scale);

d) A sampling rate of not less often than once every 30 s.

9.4.2.3 Test conditions

9.4.2.3.1 During the test, the appliance shall be operated in the same manner and for the length of time specified as for the temperature test described in Clause [5.8](#).

9.4.2.3.2 If the appliance can be operated with any of its fans, heaters, or the like not functioning; with replaceable filters, or the like removed; or with fluid, or the like exhausted, this test shall be repeated a sufficient number of times with the various components not operating or with the items removed or exhausted to determine that these conditions do not result in ozone emission exceeding that specified in Clause [9.4.2.4.1](#).

9.4.2.4 Measurements and calculations

9.4.2.4.1 The exhaust air of the emission test chamber shall be used for sampling the ozone concentration in accordance with ISO 28360. The maximum ozone concentration measured shall be used to calculate the specific emission rate for the appliance by use of the following equation:

$$SER_{O_3} = C_{max} k' VP / TR$$

Where:

SER_{O_3} = Specific Emission Rate [$\mu\text{g}/\text{minute}$]

C_{max} = Maximum Measured Ozone Concentration [$\mu\text{g}/\text{m}^3$]

k' = Ozone Decay Constant with Ventilation for the Test Chamber [$1/\text{min}$] determined in accordance with ISO 28360

V = Volume of Test Chamber [m^3]

P = Atmospheric Pressure [Pa] = 101,325

T = Temperature [K] = 298

R = Gas Conversion Constant [Pa/K] = 339.8

9.4.2.4.2 The specific emission rate calculated in Clause [9.4.2.4.1](#) shall be translated to an ozone concentration within a room having a 6.5 m^2 (70 ft^2) floor area and a 2.43 m (8 ft) wall height by use of the following equation:

$$C_{LR} = [E \times T \times R] / [V \times P \times (AER + (V_d \times (A / V)))]$$

Where:

C_{LR} = Maximum Ozone Concentration [$\mu\text{g}/\text{m}^3$] within a typical small room

E = Emission Rate [$\mu\text{g}/\text{h}$] = $60 \times SER_{O_3}$ [$\mu\text{g}/\text{min}$] calculated in Clause [9.4.2.4.1](#)

T = Temperature [K] = 298

R = Gas Conversion Constant [Pa/K] = 339.8

V = Volume [m^3] = Minimum Room Volume = 15.80 m^3 (560 ft^3)

$P = \text{Atmospheric Pressure [Pa]} = 101,325$

$AER = \text{Air Exchange Rate [1/h]} = 0.2$

$V_d = \text{Deposition Velocity [m/h]} = 0.98$

$A/V = \text{Surface Area to Volume Ratio [m}^2/\text{m}^3\text{]} \text{ for the room} = 2.5$

9.4.2.4.3 An appliance shall not produce a concentration of ozone as calculated by Clause [9.4.2.4.2](#) exceeding $107 \mu\text{g O}_3/\text{m}^3$ (0.050 PPM O_3) by volume.

9.4.3 Glass impact

9.4.3.1 With reference to Clause [9.3.3.1](#), a test sample of glass shall be broken by impact to determine the acceptability of the glass cover or guard.

9.4.3.2 The test shall be conducted at $25 \pm 5^\circ\text{C}$ ($77 \pm 7.5^\circ\text{F}$).

9.4.3.3 The sample shall be weighed and the weight of 65 cm^2 (10 in^2) shall be calculated.

9.4.3.4 The lower surface of the glass sample shall be covered with adhesive tape to retain the particles when the sample breaks.

9.4.3.5 The glass shall be placed on a flat surface and shattered with a center punch at a point 30 mm (1.18 in) 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.

9.4.3.6 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 65 cm^2 (10 in^2) of the original sample.

9.5 Markings

9.5.1 With reference to the requirements in Clause [11.1.1](#), the appliance shall also be marked with the manufacturer's complete address.

9.5.2 Products shall be marked in accordance with ANSI/IESNA RP-27.3.

9.5.3 With reference to the Exception to Clause [9.3.1.3](#), the compartment shall be marked with the word "WARNING" and the following or equivalent: "Eye damage may result from directly viewing the light produced by the lamp in this apparatus. Always turn off lamp before opening this [protective] cover." The marking shall be located where readily visible during any approach to the lamp compartment.

9.5.4 Markings shall indicate to the user the proper method of replacement. For user-replaceable lamps, the permitted replacement lamps by manufacturer and part number shall be specified. Products having lamps intended for replacement only by qualified service personnel shall be clearly marked to indicate this; the marking shall be located where readily visible during any approach to the lamp compartment.

9.5.5 Equipment incorporating an interlock to reduce the risk of overexposure shall be marked with the word "WARNING" and the following or equivalent: "This cover is provided with an interlock to reduce the risk of excessive ultraviolet radiation. Do not defeat its purpose or attempt to service without removing cover completely." The marking shall be located where readily visible during any approach to defeat the interlock.

9.5.6 For products where it could be necessary for qualified service personnel to access the product while radiation is generated, or to defeat guards, interlocks, or other protective features, markings shall be provided to alert the service personnel to the risk of overexposure. Any necessary precautions shall be described in the product's instruction or maintenance manual.

9.6 Instructions

9.6.1 The instructions shall contain the manufacturer's declaration of conformity to the applicable provisions of applicable US Federal requirements, including CFR 21, Part 1040, Chapter 1, Subchapter J, Radiological Health.

9.6.2 Markings of Clause [9.5](#) related to minimizing the risk of user overexposure to ultraviolet radiation shall be repeated under the Important Safety Instructions specified in Clause [12.2](#).

9.6.3 Except as permitted by Clause [9.3.1.3](#) for relamping, equipment with ultraviolet radiation levels over $0.1 \mu\text{W}/\text{cm}^2$ while under service conditions shall be provided with instructions indicating the need for all servicing to be performed by qualified personnel.

9.6.4 Equipment specified only for commercial or industrial applications shall be provided with instructions indicating the need to take precautions to insure that the concentration of ozone is limited to a safe value.

10 Manufacturing and Production Tests

10.1 Dielectric voltage-withstand

10.1.1 Each appliance shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 Hz between the primary wiring and:

- a) Accessible noncurrent-carrying metal parts that are likely to become energized; and
- b) Accessible extra-low voltage (42.4 V peak or less) metal parts, including terminals.

10.1.2 The production-line test shall be in accordance with either Condition A or Condition B of [Table 17](#).

10.1.3 The appliance may be in a heated or unheated condition for the test.

10.1.4 The test shall 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 need not be in place.

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

10.1.5 If the appliance employs a solid-state component that is not relied upon to reduce a risk of electric shock and that can be damaged by the dielectric voltage-withstand potential, the test mentioned in Clause [10.1.1](#) may be conducted before the component is electrically connected provided a random sampling of each day's production is tested at the potential specified in [Table 17](#). The circuitry may be rearranged for the purpose of this test to reduce the likelihood of solid-state component damage while retaining representative dielectric stress of the circuit.

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

10.1.7 If the output rating of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

10.1.8 If the output rating of the test equipment transformer is 500 VA or more, the test potential may be indicated:

- a) By a voltmeter in the primary circuit or in a tertiary winding circuit;
- b) By a selector switch marked to indicate the test potential; or
- c) By a marking in a readily visible location to indicate the test potential of equipment having a single test potential output. When a marking is used without an indicating voltmeter, the equipment shall include a positive means, such as a power-on lamp to indicate that the manually reset switch has been reset following a dielectric breakdown.

10.1.9 Test equipment, other than that described in Clauses [10.1.6](#) – [10.1.8](#), may be used if found to accomplish the intended factory control.

10.1.10 During the test, the primary switch shall be in the on position, both sides of the primary circuit of the appliance shall be connected together and to one terminal of the test equipment, and the second test-equipment terminal shall be connected to the accessible noncurrent-carrying metal.

Exception No. 1: An appliance – resistive, high-impedance winding, or the like – having circuitry not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested with a single-pole primary switch, if used, in the OFF position, or 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 testing means applied full test potential between primary wiring and noncurrent-carrying metal parts with the switch not in the ON position.

10.2 Grounding-continuity

10.2.1 Each appliance that has a power-supply cord having a grounding conductor shall be tested, as a routine production-line test, to determine that grounding continuity exists between the grounding blade of the attachment plug and the accessible noncurrent-carrying metal parts of the appliance that are likely to become energized.

10.2.2 Only a single test need be conducted if the accessible noncurrent-carrying metal part selected is conductively connected by design to all other accessible noncurrent-carrying metal parts.

10.2.3 Any suitable indicating device – an ohmmeter, a battery-and-buzzer combination, or the like – may be used to determine compliance with the grounding continuity requirement in Clause [10.2.1](#).

11 Marking

11.1 General

11.1.1 An appliance shall be plainly and permanently marked where it will be readily visible – after installation, in the case of a permanently connected appliance – with;

- a) The manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product may be identified;
- b) A distinctive catalog number or the equivalent;
- c) The date or other dating period of manufacture not exceeding any three month period;
- d) The electrical rating; and
- e) For an appliance intended for connection to a 120/240 V, 3-wire, single-phase power source – "3-wire."

Exception No. 1: The manufacturer's identification may be in a traceable code if the appliance is identified by the brand or trademark owned by a private labeler.

Exception No. 2: The date of manufacture may be abbreviated or in a nationally accepted conventional code or in a code affirmed by the manufacturer, provided that the code:

- a) Does not repeat in less than 10 years for a household appliance, and less than 20 years for a commercial appliance; and*
- b) Does not require reference to the manufacturer's records to determine when the appliance was manufactured.*

11.1.2 The electrical rating specified in Clause [11.1.1\(d\)](#) shall include volts, frequency – expressed in hertz, Hz or DC, or both – and amperes. Watts may also be included. The number of phases shall be included in the rating of an appliance intended for use on a polyphase circuit. No other ratings, such as horsepower, shall be included.

Exception: The international symbol for the nature of supply $\overline{\text{---}}$ may be used instead of "DC" if the significance of this symbol is explained in the instructions packaged with the product. When this symbol is used it shall be placed next to the marking for rated voltage.

11.1.3 An appliance having provision for an electrical attachment, such as a motorized nozzle, that is not provided with the appliance shall be marked in accordance with Clause [11.1.2](#) to separately identify the input with and without the attachment. See Clause [11.1.4](#).

11.1.4 An appliance having provision for an electrical attachment, such as a motorized nozzle, that is not provided with the appliance shall be marked on the surface adjacent to the power receptacle to specify the attachment intended to be used.

11.1.5 An attachment and/or proprietary fluid that is packaged and marketed separately from the basic appliance shall be marked with a distinctive catalog number or the equivalent. See Clause [12.7](#) as it relates to cleaning fluid designations.

Exception: A non-electrical attachment, such as a crevice tool, an upholstery brush, or the like that has no driven parts and is intended to facilitate a cleaning operation without the use of a liquid need not be

investigated. This exception does not apply to a non-electrical hard surface attachment intended for use with a proprietary fluid.

11.1.6 An appliance provided with one or more general-use receptacles shall be marked in accordance with Clause [11.1.2](#) to separately identify the input with and without the receptacle rating(s). See Clause [11.4.22](#).

11.1.7 A vacuum cleaner with a steam-cleaning attachment shall be marked in accordance with Clause [11.1.2](#) to separately identify the vacuum input, steam cleaner input, and the total combined input if the vacuum cleaner and steam cleaner can be operated simultaneously.

11.1.8 The symbols in Annex [C](#) may be used in place of the required text if the significance of the symbol is explained in the instructions.

11.2 Permanence

11.2.1 Markings required by this Standard shall be permanent and shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, handling, storage and the like of an appliance shall be considered in the determination of the permanence of a marking.

11.2.2 Unless it has been investigated and found to be acceptable for the application, a pressure-sensitive label or a label that is secured by cement or adhesive and that is required to be permanent shall comply with Clause [4.1.2.1](#).

11.3 Details

11.3.1 If the appliance is equipped with a single motor as the only electrical energy consuming component and the electrical rating appears on the motor nameplate, the rating need not appear elsewhere on the equipment, provided that the motor nameplate is readily visible with the motor installed as intended. See Clause [5.7.1](#).

11.3.2 A cord-connected appliance equipped with a dual-voltage motor with the motor nameplate used to show the electrical rating, as indicated in Clause [11.3.1](#), shall be provided with an additional permanent marking to indicate the particular voltage for which the equipment is intended to be connected when shipped from the factory.

11.3.3 If a manufacturer produces or assembles appliances at more than one factory, each finished appliance shall have a distinctive marking by which it may be identified as the product of a particular factory. This marking need not be readily visible.

11.3.4 If the capacitor or capacitor/transformer unit mentioned in Clause [4.12.4](#) is not physically a part of the appliance, it shall be marked with an identification symbol. This symbol shall also appear on the nameplate of the motor.

11.3.5 If an appliance will not start and reach normal running speed when connected to a circuit protected by an ordinary – not a time-delay – fuse as described in Clause [5.6.1](#), the appliance shall be plainly marked with the following or the equivalent, "If connected to a circuit protected by fuses, use time-delay fuses, marked Type D, with this appliance."

11.3.6 A stationary appliance employing an attachment plug in accordance with Exception No. 1 to Clause [4.5.1.7](#) shall be marked "Connect To Individual Branch Circuit." This marking shall be included with the electrical rating marking of Clause [11.1.1](#).

11.3.7 A commercial vacuum cleaner employing an attachment plug in accordance with Exception No. 2 to Clause [4.5.1.7](#) shall be marked "Connect Only To A Dedicated Individual Branch Circuit." This marking shall be included with the electrical rating marking specified in Clause [11.1.1](#)(d).

11.3.8 An appliance shall not be marked with a double insulation symbol (a square within a square), the words "double insulation," or the equivalent unless it complies with the requirements for double insulated appliances specified in Clause [6](#).

11.3.9 A double insulated appliance shall be permanently marked with the statement "DOUBLE INSULATION – When servicing, use only identical replacement parts." The words "DOUBLE INSULATED" or the double insulation symbol – a square within a square – may be used instead of "DOUBLE INSULATION" in the marking.

11.3.10 If a specific spacing is necessary between a central vacuum cleaner and the surfaces of the test alcove described in Clause [5.2.3.1](#) to reduce the likelihood of attaining temperatures within the appliance or on adjacent surfaces in excess of those specified in [Table 9](#), the appliance shall be permanently marked in a location that will be readily visible after installation with the following or the equivalent: "Mount at least...inches from side walls (and floor or ceiling)."

11.3.11 If an outdoor exhaust is necessary on a central vacuum cleaner to reduce the likelihood of attaining temperatures within the appliance or on adjacent surfaces in excess of those specified in [Table 9](#), the appliance shall be permanently marked in a location readily visible after installation as intended to make the user aware of the necessity for outdoor exhausting. See Clause [12.5.5](#).

11.3.12 An appliance for which it is necessary that exhaust air be vented for proper operation, or an appliance provided with instructions or markings that specify that exhaust air be vented, shall be marked, in a location that will be visible when the exhaust system is being installed, with explicit instructions specifying:

- a) How the appliance shall be vented; and
- b) That the exhaust air shall not be vented into a wall, a ceiling, or a concealed space of a building.

Exception: See Clause [12.5.6](#).

11.3.13 Unless it has been investigated and found to be acceptable for commercial use, an appliance shall be marked "For Household Use Only," "Household Type," or the equivalent.

11.3.14 If an appliance is provided with a power-supply cord 457-mm (18-in) long or less or with a connector base (motor-attachment plug) in accordance with Clause [4.5.1.18](#), a statement shall be marked on the appliance or be in the instructions packaged with the appliance advising of:

- a) The availability of an extension cord;
- b) The cord description by means of gage and, in accordance with Clause [4.5.1.6](#), construction type; and
- c) The importance of using such a cord; see Clause [12.2.7](#)(k).

11.3.15 A product identified for pick-up of potentially hazardous substances (such as asbestos) shall be marked: "The Use Of This Machine In Conjunction With The Pick-Up of * Has Not Been Investigated By **."

* Replaced with substances for which the product has been investigated to pick-up.

** Replaced with name of organization certifying compliance with this Standard.

11.3.16 An appliance provided with a Class 2 power source with output terminals for connection of external wiring to the output of the power source shall be marked adjacent to the terminals with the following or equivalent:

- a) For an output of 15 V or less: "Class 2, _____ V." (the blank shall be replaced with the nominal open-circuit voltage present at the terminals); and
- b) For an output greater than 15 V: "Class 2 Not Wet, _____ V." (the blank shall be replaced with the nominal open-circuit voltage present at the terminals.)

11.4 Cautionary

11.4.1 A marking shall be provided on an appliance to inform the user of a risk of injury that is not obvious.



11.4.2 A marking intended to reduce the risk of fire, injury, or electric shock shall be provided in both English and French. Annex H lists some examples of French translations of the marking specified by this standard.

11.4.3 A marking intended to reduce the risk of injury to persons shall be permanent and shall be located on a part that cannot be:

- a) Removed without impairing the operation of the appliance; or
- b) Left off of the appliance without its being readily apparent.

11.4.4 A cautionary marking shall be prefixed by a signal word "DANGER," "WARNING," or "CAUTION." The marking shall be in letters not less than 2.4-mm (3/32-in) high. If contrasting colors are used, all text, other than the signal word, shall be in letters not less than 1.6 mm (1/16 in) high. The signal word shall be more prominent than any other required marking on the appliance.

11.4.5 If a cautionary marking is molded or stamped in a material not having a contrasting background color or texture, the required marking shall have a depth or raised height above the background surface of at least 0.51 mm (0.020 in).

11.4.6 If, when energized, an appliance has a moving part that may cause injury to persons, a motor control switch on the appliance, other than a momentary-contact switch or a push-on/push-off switch, shall have a plainly marked off position. International symbols  and  may be used if the significance of these symbols is explained in the instructions packaged with the product.

11.4.7 An appliance having provision for two or more separate connections to a branch circuit or other power-supply source shall be permanently marked with the word "CAUTION" and the following or the equivalent, "This appliance has more than one connection to the source of supply. To reduce the risk of electric shock, disconnect all such connections before servicing." The marking shall be located at each point of connection and shall be readily visible after installation of the appliance.

11.4.8 An appliance or an accessory of a type mentioned in Table 18 shall be provided with a permanent marking containing the applicable warning. The wording of the marking shall be as stated in Table 18 or shall be in equally definitive terminology containing all three required parts of the marking specified. These three required parts are the signal word, the risk statement, and the risk reduction statement. The marking shall be readily visible while the appliance or accessory is in use or being readied for use. See Clauses 11.4.10 – 11.4.14.

11.4.9 The warning marking required by Clause 11.4.7 and Table 18 may be provided on the non-detachable power supply cord in the form of a cord tag; see Cord tags, Clause 11.5.

11.4.10 With reference to the requirement in Clause [11.4.7](#), a marking that combines two or more applicable warnings need not include the signal word "WARNING" more than once.

11.4.11 The warning marking required by Clause [11.4.7](#) and [Table 18](#) may be supplemented with a statement indicating the intended use of the product provided:

- a) The product has been investigated for this use; and
- b) The supplement is no longer than the warning specified in [Table 18](#) and is in smaller print.

11.4.12 If the appliance cannot be used without a hose, the marking required in Clause [11.4.7](#) may be located on the hose, instead of on the appliance, in the area of the handle and in such a manner and location that it will be readily visible to the user during normal operation.

11.4.13 If the appliance, such as an upright vacuum cleaner, can be used with or without a hose and if the marking on the appliance is not visible when the hose is being used, the marking required by Clause [11.4.7](#) shall also be marked on the hose in accordance with Clause [11.4.10](#).

11.4.14 A central vacuum cleaner not intended for wet pick-up shall be marked in accordance with Item 6 of [Table 18](#). If the hose is provided by the manufacturer, it shall also be marked in the area of the handle and in such a manner and location that it will be visible to the user during normal operation.

11.4.15 A permanently-connected vacuum cleaner intended for outdoor use and any vacuum cleaner intended for use where gasoline or other volatile flammable liquids are transferred to fuel tanks of vehicles shall be permanently marked in a location where it will be readily visible after installation with the word "DANGER" and the following statement or the equivalent: "This equipment incorporates parts such as switches, motors, or the like that tend to produce arcs or sparks that can cause an explosion. When located in gasoline-dispensing and service stations install and use at least 6 m (20 ft) horizontally from the exterior enclosure of any dispensing pump and at least 450 mm (18 in) above a driveway or ground level." See Clause [12.5.8](#).

11.4.16 A part of an enclosure as described in the Exception to Clause [4.20.3.2](#) shall be marked to indicate that such servicing is to be done with the appliance disconnected from the supply circuit as follows or the equivalent:

"CAUTION – To Reduce The Risk Of Injury From Moving Parts – Unplug Before Servicing."

11.4.17 A motor-driven brush as described in Exception No. 3 of Clause [4.20.3.1](#) shall be marked to indicate that the brush may start unexpectedly and cleaning and servicing is to be done with the appliance disconnected from the supply circuit as follows or the equivalent:

"CAUTION – Risk Of Injury. Brush May Start Unexpectedly. Unplug Before Cleaning or Servicing."

11.4.18 If the construction of an appliance is such that cleaning or similar servicing to be done by the user (such as replacement of pilot lamps, fuses, drive belts, and the like) involves the exposure of any normally enclosed or protected uninsulated live parts to unintentional contact, the appliance shall be clearly and permanently marked with the following, or equivalent wording:

"WARNING – TO REDUCE THE RISK OF ELECTRIC SHOCK– UNPLUG BEFORE CLEANING OR SERVICING."

11.4.19 If any point within a terminal box or wiring compartment of a permanently connected appliance in which the power-supply conductors are intended to be connected, including such conductors themselves, attains a temperature rise of more than 35°C (63°F) during the normal-temperature test, the appliance

shall be marked: "CAUTION – For supply connection, use wires rated for at least ____ °C (____ °F)," or with an equivalent statement. The temperature value shall be in accordance with [Table 19](#). This statement shall be located at or near the point where the supply connections are to be made, and shall be clearly visible both during and after installation of the appliance.

11.4.20 A wet pick-up current-carrying hose shall be marked with the following or equivalent wording:

"WARNING – This hose contains electric wires. To reduce risk of electric shock do not use or repair a damaged hose."

11.4.21 An appliance provided with a removable float for wet pick-up operation shall be marked with the following or the equivalent:

"WARNING – To reduce the risk of electric shock, always install float before any wet pick-up operation."

11.4.22 A dust extractor or a cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle or receptacles in accordance with the Exception to Clause [4.14.1](#) shall be marked with the word "CAUTION" and the following or the equivalent in items (a) – (c) below. A single marking may apply to several receptacles provided the marking is near to all of them.

- a) Near all receptacles: "Risk of fire. Do not exceed (the current rating of the vacuum) Amps.", or equivalent.", or the equivalent.
- b) For switched receptacles located on or near the receptacles: "Risk of injury. This is a switched receptacle and is energized when turned ON", or the equivalent.
- c) For "AUTO" receptacles located on or near the receptacles: "Risk of injury. When appliances connected to this receptacle are turned on, the (name of vacuum or appliance) will turn on automatically", or the equivalent.

11.4.23 With reference to Clause [4.5.1.13](#), the special-use detachable power supply cord shall be provided with the following marking or equivalent "Only For Use With + Model ** Vacuum Cleaner. + Part No. *** Supply Cord Rated **** V, **** A, With **** °C Connector."

+ Replace with the vacuum cleaner manufacturer's name.

** Replace with the vacuum cleaner manufacturer's vacuum cleaner model number.

*** Replace with the vacuum cleaner manufacturer's supply cord part number.

**** Replace with the voltage, amperage, and temperature rating, respectively, of connector.

11.4.24 With reference to Clause [4.5.1.13](#), the appliance shall be provided with the following correlation cautionary marking or equivalent "WARNING: For Use Only With + Part No. ** Supply Cord."

+ Replace with the vacuum cleaner manufacturer's name.

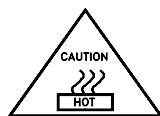
** Replace with vacuum cleaner manufacturer's supply cord part number.

11.4.25 If an appliance is shipped from the factory with a required guard detached, the appliance shall be clearly and permanently marked with the word "WARNING" and the following or the equivalent, "To reduce the risk of injury to persons, do not operate without guards in place."

11.4.26 A vacuum cleaner with a steam-cleaning attachment shall be marked with the word "CAUTION" and the following or equivalent wording, as applicable:

- a) If surface temperatures exceed the limits specified in [Table 7](#) (see Clause [4.20.4.2](#)), located on or adjacent to the surface in question: "Hot Surface." The following symbol, or an equivalent symbol, may be used in lieu of the above wording. When the symbol is used, the equilateral

triangle shall have a height not less than 38 mm (1-1/2 in). The symbol and words contained within the triangle shall be scaled proportionately to the height of the equilateral triangle.



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b) Located on the steam cleaner part of the appliance:

- 1) Near the water fill cap: "To provide continued protection against the risk of electric shock and excessive reservoir water temperatures that may cause burns, follow instructions on filling, cleaning, and rinsing."
- 2) "To reduce the risk of burns or scalding, do not open the water fill cap when using the steam-cleaning attachment."
- 3) "To reduce the risk of scalding, do not turn over the steam-cleaning nozzle, or touch the surface of the nozzle when using the steam-cleaning attachment."

11.4.27 For a household wet/dry pick-up appliance, in which the appliance manufacturer does not provide the non-electrical container, the appliance shall be marked with the following or equivalent:

- a) "WARNING – To reduce the risk of injury, user must read instruction manual."
- b) "WARNING – To reduce the risk of electric shock, fire, or personal injury, use only with (container manufacturer's name, and distinctive catalog number or equivalent)."

11.4.28 If required by the testing of Clause [5.19.1.3](#), a utility vacuum cleaner shall be marked with the following or equivalent: "CAUTION – MOVING PARTS – DO NOT OPERATE WITHOUT CAGE AND FLOAT IN PLACE." This marking shall be near or adjacent to the filter cage.

11.4.29 A floor sweeper with a motor-driven brush as described in Clause [4.20.10.2](#) shall be marked to indicate that such servicing is to be done with the appliance disconnected from the supply circuit as follows or the equivalent: "CAUTION – To Reduce the Risk Of Injury From Moving Parts, Unplug Before Servicing."

11.4.30 A floor sweeper provided with a removable dirt container as described in Clause [4.20.10.3](#) shall be marked with the following or equivalent: "CAUTION – To reduce the risk of injury from moving parts – Do not operate the product without dirt container in place. Keep hair away from rotating brush."

11.4.31 With reference to Clause [4.5.1.5](#), a stationary appliance provided with a cord and attachment plug, and intended for outdoor use, shall be provided with the following or equivalent: "WARNING – Risk of Electric Shock. This product shall only be connected to a power supply receptacle protected by a Ground Fault Circuit Interrupter (GFCI)."

11.4.32 A self-restoring guard on a motorized nozzle as described in Clause [4.20.3.6](#) shall be marked to indicate that the appliance may present a risk of injury if the guard is retracted by coming into contact with a part of the body as follows or the equivalent: "CAUTION – Risk of Injury. Retractable Guard. Use Care When Operating Near Persons."

11.4.33 A vacuum cleaner intended for marine vessel installation not shown to comply with the requirements of the Vibration Test, Clause [5.19.6](#), or Shock Test, Clause [5.19.7](#), shall be permanently

marked, where readily visible after installation, with the following or the equivalent: "For Use Only on Vessels Over 20 m in Length."

11.4.34 A vacuum cleaner intended for R/V or marine vessel installation shall be permanently marked in an area that is visible prior to installation with the following or equivalent wording: "Refer to Installation Instructions for Proper Installation."

11.4.35 Vacuum cleaners intended for R/V or marine vessel installation shall be marked in an area that is visible prior to installation with the following or equivalent wording: WARNING – TO REDUCE THE RISK OF FIRE – DO NOT INSTALL IN ANY AREA WHERE EXPLOSIVE VAPORS OR FUMES MIGHT BE PRESENT OR IN AREAS REQUIRING IGNITION PROTECTION".

11.5 Cord tags

11.5.1 The cord tag described in Clause [11.4.9](#) shall:

- a) Be permanently affixed to an attached power-supply cord;
- b) Have the leading edge located not more than 152.4 mm (6 in) from where the cord enters the body of 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;
- d) Comply with the requirements in Clauses [11.5.2](#) – [11.5.5](#). 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 by a plastic strap or equivalent means. The strap shall not be removable without cutting; or
 - 2) A flag-type tag with an adhesive back. The tag shall be wrapped tightly once around and is to adhere to the supply cord. The ends of the tag shall adhere to each other and project as a flag. The required markings shall be positioned on the projecting flag portion of the tag.

11.5.2 Nine samples of the cord tag shall be subjected to the conditioning specified in Clause [11.5.4](#), and then subjected to the test described in Clause [11.5.5](#). As a result of the testing, the samples shall comply with the following requirements:

- a) The tag shall not tear for more than 1.6 mm (1/16 in) at any point;
- b) The tag shall not separate from the power-supply cord;
- c) The tag shall not slip or move along the length of the power-supply cord more than 12.7 mm (1/2 in);
- d) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and
- e) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

11.5.3 Each sample shall consist of a length of power-supply cord. The tag shall be affixed to the power-supply cord in the intended manner. If tags are applied by an adhesive, tests shall be conducted no sooner than 24 h after application of the tag.

11.5.4 The conditioning required by Clause [11.5.2](#) shall consist of the following:

- a) Three samples shall be in the as-received condition;
- b) Three samples shall be conditioned for 24 h in an air-circulating oven maintained at a uniform temperature of $87 \pm 1^{\circ}\text{C}$ ($188.6 \pm 1.8^{\circ}\text{F}$). Following removal from the oven, the samples shall remain at a temperature of $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$ for 30 min before testing; and
- c) Three samples shall be conditioned for 72 h in a humidity of $85 \pm 5\%$ at $32.0 \pm 2.0^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$). The samples shall be tested within 1 min after the conditioning.

11.5.5 The power-supply cord, with the attachment plug pointing up, shall be held tautly in a vertical plane. A force of 22.3 N (5 lb) shall be applied to the uppermost corner of the tag farthest from the power-supply cord, within 6.4 mm (1/4 in) of the vertical edge of the tag. The force shall be applied vertically downward in a direction parallel to the major axis of the cord and maintained for 1 min. In determining compliance with Clause [11.5.2](#)(d), manipulation is possible, such as straightening of the tag by hand.

12 Instruction Manual

Advisory Note: In Canada, there are two official languages, English and French. Annex [H](#) provides translations in French of the English instructions specified in this standard. Instructions required by this standard may have to be provided in other languages to conform with the language requirements of the country where the product is to be used.

12.1 General

12.1.1 An appliance shall be provided with legible instructions pertaining to:

- a) The risk of fire, electric shock, or injury to persons that may be associated with its use;
- b) Operation and installation;
- c) User-maintenance and storage;
- d) As applicable, grounding or double insulation; and
- e) As applicable, polarization.

12.1.2 The instructions shall indicate whether the appliance is intended for household or commercial use or both.

12.1.3 The text of all required instructions shall be in the words specified or words that are equivalent, clear, and understandable.

Exception: If an appliance is such that the specified wording is unnecessary or conflicting, the wording may be omitted or modified, as appropriate.

12.1.4 With reference to the requirements in Clause [12.1.3](#), there shall be no substitute for the signal word "WARNING", except that, in some cases, the signal word "DANGER" may be substituted for "WARNING."

12.1.5 Wording in parentheses in Clauses [12.2](#) – [12.5](#) is explanatory, indicating options, alternatives, or cross-references. Wherever the word "appliance" is used, the name of the specific appliance may be substituted in the final text.

12.2 Instructions pertaining to a risk of fire, electric shock, or injury to persons

12.2.1 Instructions pertaining to a risk of fire, electric shock, or injury to persons shall warn the user of reasonably foreseeable risks and state the precautions that should be taken to reduce such risks.

12.2.2 The instructions pertaining to a risk of fire, electric shock, or injury to persons shall be:

- a) In the first part of the manual;
- b) Before the operating instructions;
- c) Separate in format from other instructions related to assembly, operation, maintenance, and storage; and
- d) A permanent part of the manual.

12.2.3 The instructions specified in Clause [12.2.6](#) shall include all applicable markings specified in [Table 18](#); however, the signal word "WARNING" and the statement of risk need not be added. Any marking required by Clause [11.4](#) shall also be included.

12.2.4 The height of lettering in the text and illustrations of the instructions specified in Clauses [12.2.6](#) and [12.2.7](#) shall be as follows:

- a) Upper case letters – not less than 1.9 mm (5/64 in);
- b) Lower case letters – not less than 1.6 mm (1/16 in); and
- c) The statements: "IMPORTANT SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS," required by Clause [12.2.5](#), and the cautionary signal word, "WARNING," required by Clauses [12.2.6](#) and [12.3.1](#) – not less than 4.8 mm (3/16 in).

12.2.5 The statement "IMPORTANT SAFETY INSTRUCTIONS" or the equivalent shall precede the list of instructions required by Clauses [12.2.6](#) and [12.2.7](#), and the statement "SAVE THESE INSTRUCTIONS" or the equivalent shall either precede or follow the list.

12.2.6 The instructions required by Clause [12.2.1](#) shall include the items in the following list, as applicable, and any other instructions that the manufacturer deems necessary for the appliance. The list shall not include the items mentioned in Clause [12.1.2](#) or in Clauses [12.4](#) and [12.5](#). The statement "Read all instructions before using" shall precede the list of items as shown below. The items need not be numbered nor be in the order presented.

IMPORTANT SAFETY INSTRUCTIONS

When using an electrical appliance, basic precautions should always be followed, including the following:

READ ALL INSTRUCTIONS BEFORE USING (THIS APPLIANCE)

WARNING – To reduce the risk of fire, electric shock, or injury:

- a) Do not leave appliance when plugged in. Unplug from outlet when not in use and before servicing.
- b) (Applicable item from [Table 18](#), such as "Do not use outdoors or on wet surfaces"; see Clause [12.2.3](#).)

- c) Do not allow to be used as a toy. Close attention is necessary when used by or near children.
- d) Use only as described in this manual. Use only manufacturer's recommended attachments.
- e) Do not use with damaged cord or plug. If appliance is not working as it should, has been dropped, damaged, left outdoors, or dropped into water, return it to a service center.
- f) Do not pull or carry by cord, use cord as a handle, close a door on cord, or pull cord around sharp edges or corners. Do not run appliance over cord. Keep cord away from heated surfaces.
- g) Do not unplug by pulling on cord. To unplug, grasp the plug, not the cord.
- h) Do not handle plug or appliance with wet hands.
- i) Do not put any object into openings. Do not use with any opening blocked; keep free of dust, lint, hair, and anything that may reduce air flow.
- j) Keep hair, loose clothing, fingers, and all parts of body away from openings and moving parts.
- k) Turn off all controls before unplugging.
- l) Use extra care when cleaning on stairs.
- m) Do not use to pick up flammable or combustible liquids, such as gasoline, or use in areas where they may be present.

SAVE THESE INSTRUCTIONS

12.2.7 The following instructions shall be included in the list of items in addition to the items in Clause [12.2.6](#) for the appliances indicated. When more than one item applies to the appliance, all applicable items for the appliance type shall be included:

- a) For an appliance intended for use with a motorized nozzle and without a current-carrying hose: "Always turn off this appliance before connecting or disconnecting motorized nozzle."
- b) For an appliance intended for use with both a motorized nozzle and a current-carrying hose:
 - 1) "The hose contains electrical wires. Do not use when damaged, cut, or punctured. Avoid picking up sharp objects;"
 - 2) "Always turn off this appliance before connecting or disconnecting either hose or motorized nozzle;" and
 - 3) Where the hose is intended for connection to a wall valve constructed as described in Clause [8.2.3](#): "Connect hose only to a Type A wall valve," or for a hose intended for connection to a wall valve constructed as described in Clause [8.2.6](#), "Connect hose only to (valve manufacturer's name) wall valve, Cat. No. ____."
- c) For an appliance supplied with a cord reel: "Hold plug when rewinding onto cord reel. Do not allow plug to whip when rewinding."
- d) For a grounded appliance: "Connect to a properly grounded outlet only. See Grounding Instructions."
- e) For a double-insulated appliance: "This appliance is provided with double insulation. Use only identical replacement parts. See instructions for Servicing of Double-Insulated Appliances."
- f) For an appliance having a mechanical accessory other than a motorized nozzle: "Unplug before connecting (Name of mechanical accessory)."

g) For a vacuum cleaner:

- 1) "Do not pick up anything that is burning or smoking, such as cigarettes, matches, or hot ashes."
- 2) "Do not use without dust bag and/or filters in place."

h) For an electrified wall valve:

- 1) "Connect only a Type A current-carrying hose to this wall valve."
- 2) "Do not install a wall valve outdoors."
- 3) "Do not use with a damaged hose. Return hose to a service center."
- 4) "To unplug, grasp, and pull on the hose connection. Do not unplug by pulling on the hose."
- 5) "Do not handle the hose or hose connector with wet hands."

i) For a household extraction-type floor cleaning machine:

- 1) For a machine that is intended to be used with a proprietary fluid: "To Reduce the Risk of Fire and Electric Shock due to internal component damage, use only + cleaning fluid intended for use with this appliance. See the Cleaning Fluid section of this manual." The word "fluid" may be replaced with the word "product(s)."

+ Replace with the appliance manufacturer's name.

- 2) For all other machines that are not intended to be used with a proprietary fluid: "To Reduce the Risk of Fire, do not use a flammable or combustible liquid to clean a floor."

j) For a non-electrical pet-grooming tool that uses a dull metal-toothed blade: "While grooming your pet, use proper care. Handle carefully and brush gently. To prevent injury to your pet, avoid using this tool on the face of your pet."

k) For a portable commercial appliance, portable outdoor use appliance, or portable hand-supported blower cleaner that is provided with not more than 457 mm (18 in) of permanently attached flexible power-supply cord, or with a connector base (motor-attachment plug):

- 1) For outdoor use appliances: "To reduce the risk of electric shock, use only with an extension cord intended for outdoor use, such as SJW or SJTW."
- 2) "Make sure your extension cord is in good condition and is the correct size for your appliance. [Table 21](#) shows the correct size to use depending on cord length and nameplate ampere rating. If in doubt, use the next heavier gage. The smaller the gage number, the heavier the cord. An undersized extension cord will cause a drop in line voltage resulting in loss of power and overheating."

i) For grounded appliances: "Use only three-wire outdoor extension cords that have three-prong grounding plugs and grounding receptacles that accept the appliance's plug."

ii) For double-insulated appliances: "To reduce the risk of electric shock, this appliance has a polarized plug (one blade is wider than the other) and will require the use of a polarized extension cord. The appliance plug will fit into a polarized extension cord only one way. If the plug does not fit fully into the extension cord, reverse the plug. If the plug still does not fit, obtain a correct polarized extension cord. A polarized extension cord will require the use of a polarized wall outlet. This

plug will fit into the polarized wall outlet only one way. If the plug does not fit fully into the wall outlet, reverse the plug. If the plug still does not fit, contact a qualified electrician to install the proper wall outlet. Do not change the equipment plug, extension cord receptacle, or extension cord plug in any way."

3) "Warning – To reduce the risk of personal injury due to a loose electrical connection between the appliance's plug and extension cord, firmly and fully attach the appliance plug to the extension cord. Periodically check the connection while operating to ensure it is fully attached. Do not use an extension cord that provides a loose connection. A loose connection may result in overheating, fire, and increases the risk of a burning."

4) "To reduce the risk of disconnection of the appliance cord from the extension cord during operating:

i) Make a knot as shown in [Figure 27](#), or

ii) Use one of the plug-receptacle retaining straps or connectors described in this manual. (The manual shall also include a statement indicating that devices for retaining extension cords are available. The name and address of the manufacturer or brand-name distributor shall be included.); or

iii) Secure the extension cord to the appliance plug as shown or described in the Operating Instructions."

5) "Maintain Appliance With Care – Inspect extension cords periodically and replace if damaged."

l) For a vacuum cleaner with a steam cleaner attachment:

1) "Unplug from outlet before filling, rinsing, or cleaning. Do not fill with more than ____ cups of water." (or "Do not fill above the filled level mark.")

2) "Do not open the water fill cap when using the steam-cleaning attachment."

3) "Do not turn over the steam-cleaning nozzle, or touch the surface of the nozzle when using the steam-cleaning attachment."

4) "Only use water to refill the reservoir. Do not use any type of chemicals or additives."

5) "Do not apply steam directly to any person or animal."

6) "Do not touch the steam-cleaning nozzle or adjacent surfaces when steam-cleaning or when the nozzle is heated."

7) For dry pickup type: "Do not vacuum water or clean steam nozzle with water. See the cleaning instructions in the User Maintenance section of this manual."

m) A household wet/dry pick-up appliance, in which the appliance manufacturer does not provide the non-electrical container, shall be provided with the following or equivalent: "WARNING – To reduce the risk of electric shock, fire, or personal injury, use only with (container manufacturer's name, and distinctive catalog number or equivalent). Read all operating instructions."

n) For a floor sweeper: "Do not pick up anything that is burning or smoking, such as cigarettes, matches, or hot ashes."

Exception No. 1: Instructions specified in (b)(2) are not required when an investigation reveals that there is a reliable electrical connection between the appliance and accessory.

Exception No. 2: For a wall valve as described in Clause 8.2.6, instructions specified in (h)(1) shall be "Connect only (hose manufacturer's name) current-carrying hose, Cat. No. ___ to this wall valve."

Exception No. 3: For a household extraction-type floor cleaning machine for use with a proprietary fluid, instead of the instruction in (i)(1), the following instruction may be added to item 2 of Clause 12.2.6: "See the Cleaning Fluid section of this manual." The word "fluid" may be replaced with the word "product(s)."

12.2.8 If complete guarding of a moving part that could cause a risk of injury to persons would defeat the utility of an appliance, a statement shall be provided in the instruction manual to warn the user of the potential risk.

12.2.9 The instruction manual for a floor-sanding machine shall contain the word "WARNING" and the following or the equivalent: "Risk of explosion. Floor sanding can result in an explosive mixture of fine dust and air. Use floor-sanding machine only in a well-ventilated area free from any flame or match."

12.2.10 With reference to Clauses 4.5.1.13, the instruction manual shall be provided with the following text or equivalent "WARNING: To Reduce The Risk of Fire or Electric Shock Use Appliance Only With + Part No. ++ Supply Cord. If Cord is Damaged or Lost, Replace With Part No. ++."

+ Replace with the vacuum cleaner manufacturer's name.

++ Replace with the vacuum cleaner manufacturer's supply cord part number.

12.2.11 The instruction manual for appliances provided with general-use receptacles as permitted by the Exception to Clause 4.14.1 shall be provided with instructions for the use of receptacles including, if appropriate, the maximum ampacity and the function of switched or AUTO modes.

12.3 Grounding/double insulation instructions

12.3.1 For a grounded or double-insulated appliance, the instructions shall include (a) – (g), as applicable.

a) For all grounded, cord-connected appliances:

GROUNDING INSTRUCTIONS

This appliance must be grounded. If it should malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electric shock. This appliance is equipped with a cord having an equipment-grounding conductor and grounding plug. The plug must be inserted into an appropriate outlet that is properly installed and grounded in accordance with all local codes and ordinances.

WARNING – Improper connection of the equipment-grounding conductor can result in a risk of electric shock. Check with a qualified electrician or service person if you are in doubt as to whether the outlet is properly grounded. Do not modify the plug provided with the appliance – if it will not fit the outlet, have a proper outlet installed by a qualified electrician.

b) For a grounded, cord-connected appliance rated less than 15 A and intended for use on a nominal 120-V supply circuit, the instructions in either item 1 or 2:

1) This appliance is for use on a nominal 120-V circuit, and has a grounded plug that looks like the plug illustrated in sketch A in Figure 20. A temporary adaptor that looks like the adaptor illustrated in sketches B and C may be used to connect this plug to a 2-pole receptacle as shown in sketch B if a properly grounded outlet is not available. The temporary adaptor should be used only until a properly grounded outlet (sketch A) can be

installed by a qualified electrician. The green colored rigid ear, lug, or the like extending from the adaptor must be connected to a permanent ground such as a properly grounded outlet box cover. Whenever the adaptor is used, it must be held in place by a metal screw.

Exception: In Canada, the use of a temporary adaptor is not permitted by C22.1.

2) This appliance is for use on a nominal 120-V circuit and has a grounding attachment plug that looks like the plug illustrated in sketch A in [Figure 20](#). Make sure that the appliance is connected to an outlet having the same configuration as the plug. No adaptor should be used with this appliance.

c) For all other grounded, cord-connected appliances:

This appliance is for use on a circuit having a nominal rating more than 120 V (or This appliance is rated more than 15 A and is for use on a circuit having a nominal rating of 120 V) and is factory-equipped with a specific electric cord and plug to permit connection to a proper electric circuit. Make sure that the appliance is connected to an outlet having the same configuration as the plug. No adaptor should be used with this appliance. If the appliance must be reconnected for use on a different type of electric circuit, the reconnection should be made by qualified service personnel.

d) For a permanently connected appliance:

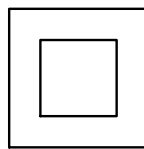
GROUNDING INSTRUCTIONS

This appliance must be connected to a grounded metal, permanent wiring system; or an equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal or lead on the appliance:

e) For a double-insulated, cord-connected appliance:

SERVICING OF DOUBLE-INSULATED APPLIANCES

A double-insulated appliance is marked with one or more of the following: The words "DOUBLE INSULATION" or "DOUBLE INSULATED" or the double insulation symbol (square within a square).



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In a double-insulated appliance, two systems of insulation are provided instead of grounding. No grounding means is provided on a double-insulated appliance, nor should a means for grounding be added to the appliance. Servicing a double-insulated appliance requires extreme care and knowledge of the system, and should be done only by qualified service personnel. Replacement parts for a double-insulated appliance must be identical to the parts they replace.

f) For a carpet cleaning appliance employing a wet pick-up current-carrying hose:

SERVICING OF WET PICK-UP ELECTRIC HOSE

WARNING – This hose contains electric wires. In order to reduce the risk of electric shock, do not use or attempt to repair a damaged hose or substitute any other type of hose. Servicing of the wet pick-up electric hose requires extreme care and knowledge of the construction. Servicing of a wet pick-up electric hose should be done only by qualified service personnel.

g) Stationary and fixed appliances intended for outdoor use and automotive vacuum cleaners for public use shall be provided with the following or equivalent:

GROUND FAULT CIRCUIT INTERRUPTER PROTECTION

To comply with C22.1/NFPA 70 and to provide additional protection from the risk of electric shock, this product shall only be connected to a receptacle (for a cord-connected appliance) or a branch circuit (for a fixed appliance) that is protected by a ground fault circuit interrupter (GFCI).

12.4 Polarization instructions

12.4.1 An appliance provided with a 2-blade, polarized attachment plug shall be provided with the following instructions or the equivalent: "To reduce the risk of electric shock, this appliance has a polarized plug (one blade is wider than the other). This plug will 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 to install the proper outlet. Do not change the plug in any way."

12.5 Installation and operating instructions

12.5.1 The installation and operating instructions shall include all information needed to assemble, install, and operate the appliance.

12.5.2 The installation instructions of a permanently connected appliance, such as a central vacuum cleaner, shall not recommend that an installer, such as a qualified electrician, cut (or bend over) and insulate the grounding conductor from a field wiring supply cable.

12.5.3 With reference to the requirement in Clause [4.5.1.18](#), a statement advising of the availability of an acceptable extension cord, its description, and the importance of using such a cord may be included in the operating instructions. See Clause [12.2.7\(k\)](#).

12.5.4 If an appliance with a dual-voltage motor employs an attachment plug, instructions shall be provided to indicate the type of plug that should be used if the appliance is reconnected for the alternate voltage.

12.5.5 For a central vacuum cleaner, if an outdoor exhaust is specified by the manufacturer or required and the appliance is marked in accordance with Clause [11.3.11](#), instructions describing the method of exhausting shall be included in the installation and operating instructions provided with the appliance.

12.5.6 The marking specified in Clause [11.3.12](#), as an alternative, may be included in the installation instructions.

12.5.7 The operating instructions shall identify by catalog number or the equivalent which separately packaged and marketed attachments have been investigated for use with the basic appliance. See Clauses [2.1](#), and [12.7](#) as it relates to the cleaning fluid designations.

Exception: This requirement does not preclude the investigation of any attachment made available in the future. The information packaged with such an attachment shall include the model number of the basic appliance with which it is to be used.

12.5.8 Instructions for a permanently connected vacuum cleaner intended for outdoor use and any vacuum cleaner intended for use in areas where gasoline or other volatile flammable liquids are transferred to fuel tanks of vehicles shall also include the information provided by the marking specified in Clause [11.4.15](#).

12.5.9 The installation instructions provided with a central vacuum cleaner employing a power supply cord less than 1.82 m (6 ft) in length shall indicate the length of the power supply cord provided on the product, and shall advise the user that the product should be mounted such that the product's power supply cord can be directly plugged into an electrical outlet. It shall also indicate that an extension cord should not be used.

12.5.10 The instructions provided with a carpet cleaning appliance provided with a wet pick-up current carrying hose shall include the following:

- a) "This hose is to be examined periodically for visible deterioration, such as abrasion, cracks, splits and the like."
- b) "This hose is to be used only for indoor household carpet cleaning applications using only manufacturer's recommended cleaning solution."

12.5.11 The instructions shall include specific instructions for an appliance intended for wet pick-up operation, and provided with a removable float, to inform the user to install the float in the recommended manner before any wet pick-up operation.

12.5.12 The instructions for a current-carrying hose as described in Clause [8.2.5](#) and a wall valve as described in Clause [8.2.3](#) shall include the word "WARNING" and the following:

- a) For the wall valve: "To reduce the risk of electric shock, connect only a motorized nozzle/current-carrying hose combination intended for connection to a Type A central vacuum cleaning system wall valve."; and
- b) For the motorized nozzle/current-carrying hose combination: "To reduce the risk of electric shock, connect only to a Type A central vacuum cleaning system wall valve."

12.5.13 The instructions for a current-carrying hose/electrified wall-valve combination as described in Clause [8.2.6](#) shall include the word "WARNING" and the following or the equivalent:

- a) For the wall valve: "To reduce the risk of electric shock, connect only (hose manufacturer's name) electric hose, Cat. No. ___ to this wall valve."; and
- b) For the motorized nozzle/current-carrying hose combination: "To reduce the risk of electric shock, connect only to (valve manufacturer's name) electrified wall valve, Cat. No. ___."

12.5.14 The instructions for an electrified wall valve shall contain the following statements or the equivalent:

- a) "For Household Use Only.";
- b) "Install only on a nominal 120 V supply protected by a maximum 20 A overcurrent protective device."; and
- c) "The pin connector on this wall valve is intended for use on a nominal 120 V supply only. It is required to be wired by a qualified electrician and is required to conform to local electrical codes."

12.5.15 The packaging for an electrified wall valve as described in Clause [8.2.3](#) shall be marked: "For use only with central vacuum cleaning system motorized nozzles that employ a Type A current-carrying hose."

Exception: The packaging for a current-carrying hose and for an electrified wall valve as described in Clause [8.2.6](#) shall be marked with the word "WARNING" and the following:

a) For the wall valve: "To reduce the risk of electric shock, use only with (hose manufacturer's name) electric hose, Cat. No. ____"; and

b) For the motorized nozzle/current-carrying hose combination: "To reduce the risk of electric shock, only connect this product to (valve manufacturer's name) electrified wall valve, Cat. No. ____."

12.5.16 The instructions provided with a vacuum cleaner with a steam cleaner attachment shall include the following:

- a) Explanation of the switches or controls associated with the vacuum and steam-cleaning modes;
- b) Explanation of the steam switch actuator or control;
- c) Instructions on how to properly fill and refill the water reservoir; and
- d) Explanation that water appearing on the floor when using the steam-cleaning attachment is part of the normal operation of the appliance.

12.5.17 For a household wet/dry pick-up appliance, in which the non-electrical container is not provided by the appliance manufacturer, the operating instructions shall include the following container information:

- a) Manufacturer's name;
- b) Distinctive catalog number or equivalent;
- c) Material (plastic or metal), capacity (gallons and/or liters), height, and diameter;
- d) Generic material (plastic or metal), and diameter of container handle;
- e) Illustration or photo; and
- f) Where user can purchase the container.

12.5.18 If required by the testing of Clause [5.19.1.3](#), a utility vacuum cleaner shall be provided with instructions informing the user of the recommended manner to install the cage.

12.5.19 Operating instructions for a floor sweeper provided with an interlock system shall explain and describe the location and function of the interlock system, and warn the user against purposely bypassing or defeating the interlock system.

12.5.20 The installation instructions shall have a separate section for R/V or marine vessel installation that specifically describes the:

- a) Proper installation of the vacuum cleaner to reduce the likelihood of falling as a result of pitch and roll;
- b) Proper ventilation needed;
- c) Ambient temperature range that should not be exceeded;
- d) Proper branch circuit protection;
- e) the requirement that the vacuum cleaner shall be installed in an enclosed accommodation space; and
- f) Applicable installation code for the intended use.

12.5.21 Vacuum cleaners intended for R/V or marine vessel installation shall include the following or equivalent wording: "WARNING – TO REDUCE THE RISK OF FIRE – DO NOT INSTALL IN ANY AREA WHERE EXPLOSIVE VAPORS OR FUMES MIGHT BE PRESENT OR IN AREAS REQUIRING IGNITION PROTECTION".

12.6 User-maintenance instructions

12.6.1 User-maintenance instructions shall include:

- a) Instructions for cleaning and user-maintenance operations recommended by the manufacturer, such as lubrication or nonlubrication, and a statement to the user that any other servicing should be performed by an authorized service representative or that the appliance has no user serviceable parts;
- b) Instructions for an appliance employing an automatically reset thermal limiter that shuts off the entire appliance or any operating part of the appliance shall inform the user of what is expected if the thermal limiter operates; and
- c) Specific instructions for the proper method of storage of the cord, the total appliance, and the like, when the appliance is not in use, and for care of the cord while in use.

12.6.2 User-maintenance instructions for a vacuum cleaner with a steam cleaner attachment shall include:

- a) Instructions to carefully inspect the steam nozzle(s) for possible clogging; and
- b) Instructions for properly cleaning of the steam nozzle.

12.7 Proprietary fluid instructions

12.7.1 For a household extraction-type floor cleaning machine that is to be used with a proprietary fluid in accordance with Exception No. 2 of Clause [5.12.8.1.1](#), the instruction manual shall contain a Cleaning Fluid (or Cleaning Product) section. The following instruction shall be included in the first part of the section: "WARNING: To Reduce the Risk of Fire and Electric Shock due to internal component damage, use only + cleaning fluid intended for use with the appliance." The "+" is replaced with the appliance manufacturer's name. The word "fluid" may be replaced by the word "product(s)." The section shall also include the recommended cleaning fluid, or a list of recommended cleaning fluids, identified by the appliance manufacturer's name and cleaning fluid identification. The cleaning fluid identification is considered the designation, product name, or number assigned to the cleaning fluid by the manufacturer and that is marked on the package containing the fluid. Only a proprietary fluid in compliance with the tests specified in Clause [5.12.8.2](#) shall be mentioned.

12.7.2 If a hard surface attachment is recommended for use with an appliance, but is not packaged with the appliance, the instruction manual shall contain the following statement, or equivalent, in the Cleaning Fluid (or Cleaning Product) or Operation Instructions section: "WARNING: To Reduce the Risk of Fire and Electric Shock. When cleaning a hard surface, the + hard surface attachment must be used and is only to be used with the ++ cleaning fluid intended for use with this appliance." The "+" is replaced with the appliance manufacturer's name and attachment model (catalog or part) number. The "++" is replaced with the appliance manufacturer's name. The word "fluid" may be replaced by the word "product(s)." The section shall also include the recommended cleaning fluid, or a list of recommended cleaning fluids, identified by the appliance manufacturer's name and cleaning fluid identification. The cleaning fluid identification is considered the designation, product name, or number assigned to the cleaning fluid by the manufacturer and that is marked on the package containing the fluid. Only a proprietary fluid in compliance with the tests specified in Clause [5.12.8.2](#) shall be mentioned.

Table 1
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

(See Clauses [4.2.5.1](#) and [4.2.5.2](#))

Minimum dimension ^a of opening ^b		Minimum distance from opening to part ^b	
mm	(in)	mm	(in)
19.1 ^c	(3/4)	114.0	(4-1/2)
25.4	(1)	165.0	(6-1/2)
31.8	(1-1/4)	190.0	(7-1/2)
38.1	(1-1/2)	318.0	(12-1/2)
47.6	(1-7/8)	394.0	(15-1/2)
54.0	(2-1/8)	444.0	(17-1/2)
	d	762.0	(30)

^a See Clause [4.2.5.5](#).

^b Between 25.4 and 54.0 mm (1 and 2-1/8 in), interpolation is to be used to determine a value between values specified in this table.

^c Any dimension less than 25.4 mm (1 in) applies to a motor only.

^d More than 54.0 mm (2-1/8 in) but not more than 152 mm (6 in).

Table 2
Cord types

(See Clause [4.5.1.6](#))

Appliance	Type of cord
Automotive and garage	S, ST ^{a,b}
Household, indoor use	SV, SVT ^e
Household, outdoor use	c
Commercial vacuum cleaners or blower cleaners	SJ, SJT ^d
Central vacuum cleaner	SJ, SJT
Household, indoor use, vacuum cleaner with steam-cleaning attachment, where temperatures are more than 121°C (250°F) on any surface that the cord is likely to touch when the appliance is used as intended	HPD, HPN, HSJ, HSJOO, or HSJO

^a An oil-resistant cord is required when the equipment is likely to be subjected to grease or oil.

^b Type SJ, or SJT cord is usable when the appliance is intended to be installed or used in a separate room provided for the purpose.

^c A household use vacuum cleaner and a household use, floor supported vacuum cleaner with an integral port provided for use as a blower, both intended primarily for indoor use and occasional outdoor use and marked according to item 3 or 5 of [Table 18](#) shall employ a Type SV or SVT cord. A household use vacuum cleaner intended primarily for outdoor use and a household blower cleaner intended for outdoor use shall employ a SJW or SJTW cord.

^d Cord marked with suffix "W" (such as, SJTW) is required when the appliance is intended for outdoor use.

^e Type SPT-1, -2, or -3; or SP-1, -2, or -3 cord may be used in locations that are protected or otherwise prevent the cord from being subjected to the same level of wear and abuse as the power cord, such as for an external connecting cord permanently attached to a wand.

Table 3
Polarity identification of flexible cords

(See Clause [4.5.1.8](#))

Method of identification	Acceptable combinations	
	Conductor intended to be grounded ^a	All other conductors ^a
Color of braids on individual conductors	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	Color other than white or gray – with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	Solid white or gray ^b	Solid color other than white or gray
	Solid light blue ^c	Solid color other than light blue, white, or gray
Color of separators	Solid white or gray ^d	Solid color other than white, or gray
^a A conductor finished to show a green color with or without one or more yellow stripes or tracers shall be used only as an equipment-grounding conductor. See Clause 4.16.5 and Figure 5 . ^b Only for cords having no braid on any individual conductor. ^c For jacketed cords. ^d Only for cords having insulation on the individual conductors integral with the jacket.		

Table 4
Material property

(See Clauses [4.8.2](#), [4.15.2.3](#), [5.21.2.1](#) and [5.21.2.2](#))

Material property (units)	Flame rating of material			
	V-0	V-1	V-2	HB
HAI (arcs)	≥ 15	≥ 30	≥ 30	≥ 60
(PLC) ^a	(3)	(2)	(2)	(1)
HWI (seconds)	≥ 7	≥ 15	≥ 30	≥ 30
(PLC) ^a	(4)	(3)	(2)	(2)
^a PLC is the performance level category in accordance with UL 746A.				

Table 5
Minimum spacings for uninsulated live parts at supply wiring terminals

(See Clauses [4.12.7](#), [4.15.1.1](#), [4.15.1.2](#) and [4.15.1.3](#))

Potential involved	Over surface		Through air	
	V		V	
	mm	(in)	mm	(in)
250 or less	6.4	(1/4)	6.4	(1/4)
NOTE – 1. For extra-low voltage circuits, see Clause 4.7.4.3 . 2. These spacings do not apply to connecting straps or buses extending away from wiring terminals; such spacings are judged under the requirements of Table 6 .				

Table 6
Minimum spacings at other than supply wiring terminals

(See Clauses [4.15.1.1](#), [4.15.1.4](#), [4.15.1.5](#), [4.15.1.9](#) and [4.15.1.10](#) and Table [Table 5](#))

Potential involved V	Rating of motor employed ^a	Motor Diameter 178 mm (7 in) or less ^b			
		Over surface		Through air	
		mm	(in)	mm	(in)
0 – 125	1/3 hp (250 W output) or less	1.6	(1/16)	1.6	(1/16)
	More than 1/3 hp	2.4	(3/32)	2.4	(3/32)
126 – 250	All motors	2.4	(3/32)	2.4	(3/32)

NOTE – For extra low voltage circuits, see Clause [4.15.1.4](#).

^a See Clause [4.15.1.10](#) for motors that are not rated in horsepower. For universal motors in appliances rated for use on ac circuits, the table below shall be used.

115 ac, single phase	7.2 A
230 ac, single phase	3.6 A

^b 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 motor mounting, cooling, assembly, or connection.

Table 7
Maximum surface temperatures

(See Clause [4.20.4.1](#))

Location	Composition of surfaces ^a			
	Metallic		Nonmetallic	
A handle or knob that is grasped for lifting, carrying or holding	50°C	(122°F)	60°C	(140°F)
A handle or knob that is contacted but does not involve lifting, carrying, or holding and other surfaces subjected to contact in operation and user maintenance	60°C	(140°F)	85°C	(185°F)
A surface subject to casual contact	70°C	(158°F)	95°C	(203°F)

^a A handle, knob or the like made of a material other than metal that is plated or clad with metal, having a thickness of 0.13 mm (0.005 in) or less, is judged as a nonmetallic part.

Table 8
Test voltages

(See Clause [5.1.2](#))

Appliance marked rating V	Test voltage V
110 – 120	120
200 – 208	208
220 – 240	240

Table 9
Maximum acceptable temperature rises

(See Clauses [5.8.1](#), [5.8.3](#), [5.9.1.1](#), [5.18.1](#), [8.8.1](#), [11.3.10](#) and [11.3.11](#))

Materials and component parts	°C	(°F)
1. Varnished-cloth insulation	60	(108)
2. Fuses	65	(117)
3. Fiber employed as electrical insulation	65	(117)
4. Wood and other flammable material	65	(117)
5. At any point within a terminal box or wiring compartment of a permanently connected appliance in which power-supply conductors are to be connected, including such conductors themselves, unless the appliance is marked in accordance with Clause 11.4.19	35	(63)
6. A surface upon which a stationary appliance can be mounted in service, and surfaces that can be adjacent to the appliance when so mounted	65	(117)
7. Class A (105°C) insulation systems on coil windings of an ac motor having a frame diameter of more than 178 mm (7 in) and of a dc motor ^{a,b} :		
(a) In an open motor and on a vibrator coil		
Thermocouple method	65	(117)
Resistance method	75	(135)
(b) In a totally enclosed motor		
Thermocouple method	70	(126)
Resistance method	80	(144)
8. Class A (105°C) insulation system on coil windings of an ac motor having a frame diameter of 178 mm (7 in) or less, of a universal motor, and on a vibrator coil ^{a,b} :		
(a) In an open motor and on a vibrator coil		
Thermocouple or resistance method	75	(135)
(b) In a totally enclosed motor		
Thermocouple or resistance method	80	(144)
9. Class B (130°C) insulation, except as indicated in items 15 and 16 ^a		
Thermocouple method	85	(153)
10. Phenolic composition employed as electrical insulation or as a part the deterioration of which would result in a risk of fire or electric shock ^c	125	(225)
11. Rubber insulated wire and cord ^c	35	(63)
12. Thermoplastic-insulated wire and cord ^c	35	(63)
13. Capacitor		
Electrolytic ^d	40	(72)
Other Types ^e	65	(117)
14. Class A (105°C) insulation on windings of relay, a solenoid, and the like ^a		
Thermocouple method	65	(117)
Resistance method	85	(153)
15. Class B (130°C) insulation on windings of relay, a solenoid, and the like ^a		
Thermocouple method	85	(153)
Resistance method	95	(171)
16. Class F (155°C) insulation on windings of relay, a solenoid, and the like ^a		
Thermocouple method	95	(171)

Table 9 Continued on Next Page

Table 9 Continued

Materials and component parts	°C	(°F)
Resistance method	115	(207)
17. Class B (130°C) insulation systems on coil windings of an ac motor having a frame diameter of more than 178 mm (7 in) and of a dc motor ^{a,b}		
(a) In an open motor		
Thermocouple method	85	(153)
Resistance method	95	(171)
(b) In a totally enclosed motor		
Thermocouple method	90	(162)
Resistance method	100	(180)
18. Class B (130°C) insulation systems on coil windings of an ac motor having a frame diameter of 178 mm (7 in) or less and of a universal motor ^{a,b} :		
(a) In an open motor		
Thermocouple or resistance method	95	(171)
(b) In a totally enclosed motor		
Thermocouple or resistance method	100	(180)
19. Class A (105°C) insulation systems on windings of a transformer		
Thermocouple method	65	(117)
Resistance method	75	(135)
20. Class F (155°C) insulation systems on coil windings of an ac motor having a frame diameter of more than 178 mm (7 in) and of a dc motor, and a universal motor ^{a,b}		
(a) In an open motor		
Thermocouple method	110	(198)
Resistance method	120	(216)
(b) In a totally enclosed motor		
Thermocouple method	115	(207)
Resistance method	125	(225)
21. Class F (155°C) insulation systems on coil windings of an ac motor having a frame diameter of 178 mm (7 in) or less, not including a universal motor ^{a,b}		
(a) In an open motor		
Thermocouple or resistance method	120	(216)
(b) In a totally enclosed motor		
Thermocouple or resistance method	125	(225)
22. Switches, relays, controls, thermostats, temperature limiters, circuit breakers, and similar components ^f		
(a) For switches approved to UL 1054 or CSA C22.2 No. 55	40	(72)
(b) For items approved to UL 61058 or CSA 61058 – 1–9		
Without T rating	30	(54)
With T rating	T-25	(T-77)
(c) For other components without a temperature rating	35	63
^a At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by a thermocouple may be higher by the following amount than the maximum specified.		
Item	Additional Temperature Rise	
Part A of Item 7 and Item 14	15°C (27°F)	

Table 9 Continued on Next Page

Table 9 Continued

Materials and component parts	°C	(°F)
Part A of Item 8	5 °C	(9°F)
Part A of Item 15	20°C	(36°F)
Part A of Item 16	10°C	(18°F)
<p>Provided that the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table. See Clause 5.8.7.</p> <p>^b 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 motor mounting, cooling assembly, or connection.</p> <p>^c The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and found to be acceptable for a higher temperature.</p> <p>^d For an electrolytic capacitor that is integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure shall not be more than 65°C (117°F).</p> <p>^e A capacitor that operates at a temperature rise of more than 65°C (117°F) may be judged on the basis of its marked temperature limit.</p> <p>^f The temperature limit does not apply if the component has been evaluated to a higher temperature or the polymeric enclosure material of the component has a RTI value higher than the measured temperature and the device operates normally during the test while at the measured temperature.</p>		

Table 10
Extreme operating voltages

(See Clause [5.9.1.1](#))

Appliance rating, V	Test voltages, V	
	Low	High
110 – 120	104	127
200 – 208	187	220
220 – 240	208	254

Table 11
Cycling conditions

(See Clause [5.23.5.1](#))

For indoor end-use applications	For outdoor end-use applications
24 h at T ^a followed immediately by at least 96 h at 35.0 ±2.0°C (95.0 ±3.6°F), 90% relative humidity, followed by 8 h at 0.0 ±2.0°C (32.0 ±3.6°F)	A minimum of 24 h immersed in 25.0 ±2.0°C (77.0 ±3.6°F) water, followed immediately by at least 96 h at 35.0 ±2.0°C (95.0 ±3.6°F), 90% relative humidity; followed by 8 h at minus 35.0 ±2.0°C (minus 31.0 ±3.6°F).
^a T is the measured normal operating temperature, but not less than 60°C (140°F).	

Table 12
Abnormal overload test

(See Clause [5.26.1](#))

Overcurrent protective device rating, A	Minimum test time ^a , min		
	110% current ^b	135% current	200% current
0 – 30	7 h	60	2
31 – 60	7	60	4

^a If circuit conditions are such as to open a current carrying conductor without resulting in a risk of electric shock, fire, or injury to persons, the test circuit current shall be reduced to a point where the circuit remains intact for at least the time indicated but where maximum heating is generated.

^b The test may be terminated when the temperatures have stabilized, indicating that ultimate results have already been achieved.

Table 13
Glow-wire temperature requirements based upon a products functional end-use application

(See Clauses [4.8.2](#), [5.21.2.1](#), [5.21.2.2](#), and [5.27.3](#))

Application type	Glow-wire temperature
Portable, attended, intermittent duty, household use equipment	650°C (1202°F)
All other portable equipment	750°C (1382°F)
Fixed or stationary equipment	750°C (1382°F)

Table 14
Minimum spacings

(See Clauses [6.3.6](#), [6.10.1](#), [6.11.1](#), [6.16.2](#), [6.17.4.3](#), [6.19.1](#), and [Table 15](#))

Parts between which spacings are measured	Minimum acceptable spacings
1. Uninsulated live parts and noncurrent-carrying metal parts that are separated by basic insulation only. ^a	Not less than the through air and over surface spacings specified in Clause 4.15
2. Accessible noncurrent-carrying metal parts ^b and noncurrent-carrying metal parts separated from uninsulated live parts by basic insulation only (this ordinarily is a spacing resulting from supplementary insulation).	Not less than the through air and over surface spacings specified in Clause 4.15
3. Uninsulated live parts and noncurrent-carrying metal parts ^b separated by double insulation or by reinforced insulation, where acceptable, except as indicated in item 4.	Not less than twice the through air and over surface spacings specified in Clause 4.15
4. Uninsulated live parts and accessible noncurrent-carrying metal parts ^b at a commutator or other location on which foreign materials can build up.	8.0 mm (5/16 in) over surface
5. Uninsulated live parts, including film-coated wire wound in the form of a coil and reliably held in place, and the interior surface of insulating material that serves as supplementary insulation.	0.8 mm (1/32 in)
6. Outer surface of a wrapped coil and the interior surface of insulating material that serves as supplementary insulation.	0.8 mm (1/32 in)

^a Reference Clause [4.15.1.5](#).

^b If the outer surface of the enclosure consists wholly or partially of insulating material, the spacings applied to accessible noncurrent-carrying metal also apply to metal foil wrapped tightly around and in intimate contact with the enclosure. The foil shall be drawn tightly across any opening in the enclosure to form a flat plane across such opening. See [Figure 14](#).

Table 15
Points of application and voltages for dielectric voltage-withstand test

(See Clauses [6.13.1](#) and [6.16.2](#))

Points between which potential shall be applied		Test potential in V
1.	Live parts and inaccessible noncurrent-carrying metal parts	Voltage prescribed for dielectric voltage-withstand test in Clause 5.11
2.	Inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts or for equipment with an outer enclosure of insulating material, metal foil wrapped tightly around the enclosure – see Figure 14	2000 V plus twice the rated voltage of the equipment
3.	Accessible noncurrent-carrying metal parts, or the foil mentioned in item 2, and metal foil in contact with the inner surfaces of insulating barriers provided to accomplish compliance with Table 14	2000 V plus twice the rated voltage of the equipment
4.	Accessible noncurrent-carrying metal parts and: <ul style="list-style-type: none"> a) Metal foil wrapped around the power-supply cord inside the inlet bushings, cord guards, strain-relief clamps, and the like; or b) A metal rod of the same cross-sectional dimensions as the cord and inserted in its place 	2000 V plus twice the rated voltage of the equipment
5.	Live parts and accessible noncurrent-carrying metal parts, or the foil mentioned in item 2	3500 V plus twice the rated voltage of the equipment

Table 16
Production-line dielectric voltage-withstand test potentials

(See Clause [6.20.1.1](#))

Points between which potential shall be applied ^{a, b}		Test potential in V	
		RMS	Peak
1.	Live parts and noncurrent-carrying metal parts insulated from one another by basic insulation	1000	1414
2.	Inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts insulated from one another by supplementary (protecting) insulation	1500	2122
3.	Live parts and accessible noncurrent-carrying metal parts for: <ul style="list-style-type: none"> a) body supported wet pick-up appliance b) all other appliances 	3000 2500	4242 3536
^a If necessary because of the inaccessibility of parts, tests in accordance with items 1 and 2 may be conducted on subassemblies of the equipment, and, in this case, the test indicated in item 3 shall be conducted. If the tests in accordance with items 1 and 2 are conducted on the completely assembled equipment, the tests indicated in item 3 may be omitted if there is no reinforced insulation.			
^b Those parts of the tests described in items 2 and 3 that include application of metal foil to outer enclosures of insulating material may be waived if the manufacturer has an acceptable quality-control program. This program shall determine that the insulating material in question is free from cracks and metal inclusions, and that it has the physical and electrical strength required for the application. To determine that the material is free of cracks or metal inclusions, a 100% visual inspection is required. Periodic physical-property tests on molded parts shall also be conducted.			

Table 17
Production line test conditions

(See Clauses [10.1.2](#) and [10.1.5](#))

Appliance rating and form	Condition A		Condition B	
	Potential V	Time s	Potential V	Time s
60 V or less	500	60	600	1
250 V or less with or without a motor rated 1/2 hp (373 W) or less	1000	60	1200	1
More than 250 V, or employing a motor rated more than 1/2 hp (373 W), or applied directly to persons or supported by the body of a person	1000+2V ^a	60	1200+2.4V ^a	1
A wet pick-up appliance that is supported by the body of a person but not solely hand held	2500	60	3000	1

^a V is rated voltage of the appliance.

Table 18
Warning markings

(See Clauses [4.16.9](#), [5.12.1.1](#), [5.12.8.1.2](#), [5.21.4.2](#), [5.21.8.1](#), [7.2\(h\)](#), [7.4](#), [11.4.7](#), [11.4.9](#), [11.4.14](#), [12.2.3](#), [12.2.6](#), and [Table 2](#))

Type of appliance or accessory	Marking required
1. Not grounded, not double insulated.	WARNING – To Reduce The Risk Of Electric Shock – Do not use outdoors or on wet surfaces.
2. Grounded or double-insulated, intended for indoor use only, not intended for wet pick-up.	WARNING – To Reduce The Risk Of Electric Shock – Do not use outdoors or on wet surfaces.
3. Grounded or double-insulated, intended for indoor or outdoor use – not intended for wet pick-up.	WARNING – To Reduce The Risk Of Electric Shock – Do not use on wet surfaces. Do not expose to rain. Store indoors.
4. Intended for indoor use only and for wet pick-up.	WARNING – To Reduce The Risk Of Electric Shock – Use indoors only.
5. Intended for indoor or outdoor use and for wet pick-up, but not intended to be exposed to rain.	WARNING – To Reduce The Risk Of Electric Shock – Do not expose to rain. Store indoors.
6. Central vacuum cleaners.	WARNING – To Reduce The Risk Of Electric Shock – Do not use on wet surfaces.
7. Motorized nozzle intended for dry-pickup only, may be connected to a vacuum cleaner intended for wet pick-up.	WARNING – To Reduce The Risk Of Electric Shock – Do not use motorized nozzle on wet surfaces.
8. Double-insulated motorized nozzle, may be connected to a grounded vacuum cleaner.	WARNING – Only motorized nozzle is double-insulated. To reduce risk of electric shock – Connect vacuum cleaner to a properly grounded outlet.
9. Motorized nozzle intended for use with an extraction-type carpet cleaning system.	WARNING – Do not immerse. To reduce risk of electric shock – Use only on carpet moistened by cleaning process.
10. Blowers and floor finishing machines not intended for outdoor use.	WARNING – To Reduce The Risk Of Electric Shock – Use Indoors Only.
11. Blower intended for outdoor use but not intended to be exposed to rain.	WARNING – To Reduce The Risk Of Electric Shock – Do Not Expose To Rain – Store Indoors.
12. Wet pick-up current-carrying hoses.	WARNING – This hose contains electric wires. To reduce the risk of electric shock, do not use or repair a damaged hose.
13. Wet pick-up vacuum cleaners employing a removable float for wet pick-up operation.	WARNING – To reduce the risk of electric shock, always install float before any wet pick-up operation.

Table 18 Continued on Next Page

Table 18 Continued

Type of appliance or accessory	Marking required
14. A floor scrubber, polisher, buffer, waxer, or sander, or a machine intended for multiple purposes.	WARNING – To reduce the risk of fire, use only commercially available floor cleaners and waxes intended for machine application.
15. A floor sander or multi-purpose appliance with floor sanding being one of its purposes.	WARNING – Risk of explosion. Floor sanding can result in an explosive mixture of fine dust and air. Use floor sanding machine only in well ventilated area.
16. Household extraction-type floor cleaning machines:	
a) for use with a proprietary fluid.	WARNING – To Reduce the Risk of Fire and Electric Shock – Use only + cleaning products intended for use with this machine." + Replace with appliance manufacturer's name.
b) All others.	WARNING – To Reduce the Risk of Fire – Do not use a flammable or combustible liquid to clean a floor.

Table 19
Outlet-box marking(See Clause [11.4.19](#))

Temperature rise attained in terminal box or compartment during test	Temperature marking
36 – 50°C (64 – 90°F)	75°C (167°F)
51 – 65°C (91 – 117°F)	90°C (194°F)

Table 20
Artificial-aging tests(See Clause [5.12.5.4](#))

Temperature on component during normal temperature test	Artificial-aging procedure
60°C (140°F) or less	Immersion for 168 h at 70 ±1°C (158 ±1.8°F) in a solution consisting of three times the recommended concentration of the proprietary fluid to which the component is exposed
More than 60°C (140°F)	Immersion for 168 h in a boiling solution consisting of three times the recommended concentration of the proprietary fluid to which the component is exposed
60°C (140°F) or less	Air oven aging for 70 h at 100 ±2°C (212 ±3.6°F)
61 – 90°C (142 – 194°F)	Air oven aging for 168 h at 121 ±1°C (250 ±1.8°F)
91 – 105°C (196 – 221°F)	Air oven aging for 168 h at 136 ±1°C (277 ±1.8°F)

Table 21
Minimum gauge for extension cords

(See Clause [12.2.7\(k\)](#))

Ampere rating		Volts	Total length of cord			
			7.62 m (25 ft)	15.24 m (50 ft)	30.48 m (100 ft)	45.72 m (150 ft)
More than, A	Not more than, A	120 V	mm ² (AWG)			
0	6	–	0.82 (18)	1.3 (16)	1.3 (16)	2.1 (14)
6	10	–	0.82 (18)	1.3 (16)	2.1 (14)	3.3 (12)
10	12	–	0.82 (18)	1.3 (16)	2.1 (14)	3.3 (12)

NOTE – Only the applicable parts of the Table need to be included in the manual.

Table 22
Number of cycles of operation for endurance test

(See Clause [5.2.8.5](#), [5.30.2.1](#), and [5.30.2.2](#))

Type of thermostat	Automatically reset thermostat	Manually reset thermostat
Temperature-regulating	A number of cycles equivalent to 1000 hours of normal operation of the heater but not less than 6000 cycles if a household appliance, or 30,000 cycles if a commercial appliance. However, the test may be omitted if, with the thermostat short-circuited, no temperatures higher than the limits given in Table 9 are attained during the normal-temperature test of the appliance.	To be made the subject of special consideration. ^a
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the heating appliance under any condition which causes the thermostat to function; or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in Clause 5.10.4 during the continuous abnormal operation of the appliance.	1000 cycles under load and 5000 cycles without load. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in Clause 5.10.4 during continuous abnormal operation of the appliance.
Combination temperature-regulating and -limiting	100,000 cycles if, with the thermostat short-circuited, there is evidence of risk of fire as described in Clause 5.10.4 . If there is no evidence of risk of fire under this condition, the thermostat is to be tested as a temperature-regulating thermostat (see above).	To be made the subject of special consideration. ^a

^a If the operation of the thermostat controls the physical movement of a part of the appliance, the test shall be so arranged that each cycle will involve the complete normal operation of the appliance.

Table 23
Overvoltage categories

(See Clauses [4.11.3.1](#) and [4.15.3.2](#))

Circuit	Overvoltage Category
Permanently-connected appliances	III
Line-voltage	II
Extra low-voltage	I

Table 24
Material group

(See Clauses [4.11.3.1](#) and [4.15.3.2](#))

CTI PLC value of insulating materials	Material group
CTI \geq 600 (PLC = 0)	I
400 \leq CTI < 600 (PLC = 1)	II
175 \leq CTI < 400 (PLC = 2 or 3)	IIIa
100 \leq CTI < 175 (PLC = 4)	IIIb
NOTE – PLC stands for Performance Level Category, and CTI stands for Comparative Tracking Index as specified in UL 746A.	

Table 25
Pollution degrees

(See Clauses [4.11.3.1](#) and [4.15.3.2](#))

Clearances and Creepage Distances Microenvironment	Pollution degree
<p>No pollution or only dry, nonconductive pollution. The pollution has no influence.</p> <p>Pollution degree 1 can be achieved by the encapsulation or hermetic sealing of the product. For printed circuit boards, coatings may be used that comply with the performance criteria of the Printed Wiring Board Coating Performance Test contained in UL 840.</p>	1
<p>Normally, only nonconductive pollution. However, a temporary conductivity caused by condensation may be expected.</p> <p>Pollution degree 2 can be achieved by reducing possibilities of condensation or high humidity at the creepage distance, through the provision of ventilation or the continuous application of heat, through the use of heaters or continuous energizing of the equipment when it is in use. Continuous energizing is considered to exist when the equipment is operated without interruption every day and 24 hours per day or when the equipment is operated with interruptions of a duration which do not permit cooling to the point of condensation to occur.</p> <p>Appliances that use totally enclosed motors without brushes or internal lubrication systems.</p> <p>Appliances that use open motors for use in equipment for ordinary locations and indoor use, such as:</p> <p>a) Residential appliances; and</p> <p>b) Commercial appliances for use in a clean environment.</p>	2

Table 25 Continued on Next Page

Table 25 Continued

Clearances and Creepage Distances Microenvironment	Pollution degree
Conductive pollution or dry, nonconductive pollution that becomes conductive due to condensation that is expected. Pollution degree 3 can be achieved by the use of appropriate enclosures which act to exclude or reduce environmental influences, particularly moisture in the form of water droplets. Appliances with brush-type motors, appliances intended for outdoor use, and appliances influenced by surrounding environment, such as industrial use.	3
Pollution that generates persistent conductivity through conductive dust or rain and snow.	4

Table 26
Superseded requirements

(See Clause [4.9.1.4\(b\)](#))

UL 1004-1 exempted requirement	Superseded by the requirements in this standard
Current and Horsepower Relation	Clause 4.15.1.10
Cord-Connected Motors	Clause 4.5.1
Factory Wiring Terminals and Leads	Clause 4.7
Electrical Insulation	Clause 4.8
Non-Metallic Functional Parts	Clauses 4.2 , 4.8 , and 4.9
Solid-State Controls, 7.2	Clause 4.11
Non-metallic enclosure thermal aging, 9.1.4	Clauses 4.2 and 4.8
Motor enclosure – Cast Metal Enclosures, Sheet Metal Enclosures, and Polymeric Enclosures	Clause 4.2
Grounding, and Grounding Identification	Clause 4.16
Ventilation Openings: only applicable where the openings are on surfaces considered to be the appliance enclosure.	Clause 4.2.3
Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts	Clause 4.2.5
Protection Against Corrosion	Clause 4.4
Available fault current ratings for motor start and running capacitors, Clause 26.6: not applicable for cord and plug connected appliances.	Clause 4.11
Switches is not applicable to centrifugal starting switches.	Clause 4.10
With the exception Resilient Elastomer Mounting Tests and Electrolytic Capacitor Overvoltage Tests, respectively, the performance tests are not applicable.	All applicable performance tests.
Only the following marking requirements specified in 43.1 are applicable: manufacturer's name or identification; rated voltage; rated frequency; number of phases if greater than 1; and multi-speed motors, other than a shaded-pole or a permanent-split-capacitor motor, shall be marked with the amperes and horsepower at each speed.	Clause 11.1.1

Table 27
Rating or setting of overload-protective devices

(See Clause [4.9.3.9](#))

Type of motor and marking	Maximum ampere rating of device as a percentage of motor full-load-current rating	
	A	B
Motor with marked service factor of 1.15 or greater, or with marked temperature rise of 40°C (72°F) or less ^a	125	140
Other motors	115	130

^a Motor manufacturer's applied marking.

Table 28
Construction and performance requirements for general-use receptacles provided on portable, cord-connected utility vacuums

(See Clauses [4.14.3](#), [4.14.5](#), [4.14.6](#), and [5.2.7.1](#))

Number of receptacles	Minimum supply cord size	Appliance current rating, minimum	Supplementary OCP required?	Supplementary OCP rating, if provided	Minimum internal wiring size ^a	Total receptacle load ^b
	mm ² (AWG)	A		A	mm ² (AWG)	A
6	3.3 (12)	20	Yes	20	3.3 (12)	20
5	3.3 (12)	20	No	20	3.3 (12)	20
4	2.1 (14)	15	Yes	15	2.1 (14)	15
1 – 3	2.1 (14)	15	No	15	2.1 (14)	15

^a Size of conductors through which receptacle current is drawn.

^b Additional resistive load applied equally between receptacles shall be used as the normal load in Clause [5.2.7.1](#).

Table 29
Required performance levels

(See Clause [4.11.4.1](#))

Type and purpose of function*	Safety-critical function?	Minimum Performance Level (PL) per ISO 13849-1
Prevent loss of ON/OFF control for a power switch or control with no accessible moving parts capable of causing injury.	No	
Power switches or other controls that prevent unintended operation of motors controlling accessible moving parts capable of causing injury, except for appliances with motor-operated brushes provided with the Warning marking of Clause 11.4.15 .	Yes	b
Power switches or other controls that prevent unintended operation of motors controlling appliances with motor-operated brushes provided with the Warning marking of Clause 11.4.15 .	No	—
Interlocks as required by Clauses 4.20.7.7 – 4.20.7.12 , and 9.3.1.6 .	Yes	b

Table 29 Continued on Next Page

Table 29 Continued

Type and purpose of function*	Safety-critical function?	Minimum Performance Level (PL) per ISO 13849-1
For portable appliances, prevent overload (over temperature or overcurrent) during severe conditions and abnormal operation as required by Clauses 5.9 , 5.10 , 5.21.5 , 5.21.7 , 5.24 .	Yes	a
For stationary appliances, prevent overload (overtemperature or overcurrent) during severe conditions and abnormal operation as required by Clauses 5.9 , 5.10 , 5.21.5 , 5.21.7 , 5.24 .	Yes	b
Prevent self-resetting after operation of a protective circuit that turns off the appliance where there is a risk of injury due to moving parts, not provided with the Warning marking of Clause 11.4.15 .	Yes	b
Motor speed control.	No	–
Water level sensing control, except when the control is not defeated during the test of Clause 5.12.2 .	No	–
Water level sensing control not defeated during the test of Clause 5.12.2 .	Yes	b – if there is a risk of fire; c – if there is a risk of shock (where required to meet the leakage current test)
Pump shut down due to overpressure condition.	No	–
Clogged filter sensing or self-cleaning control.	No	–
Operation of by-pass valve or motor shut down in response to obstructed working air flow, if the failure of this control would result in non-compliance with Clause 5.21.5.5 .	Yes	a – attended b – unattended
* Performance levels not specified here may be assessed by comparison to similar functions listed or through a consideration of increased residual risk created by a failure of the electronic circuit by application ISO 13849-1.		

Table 30
Additional or alternative safety-critical functions (SCFs)

(See Clause [7.8](#))

Type and purpose of SCF	Required performance level (PL)
Prevent unwanted turning on where unexpected operation exposes users or bystanders to a substantial risk of injury due to unenclosed moving parts such as beaters.	B
Provide desired switch-off of the appliance if continued operation exposes the user to a substantial risk of injury due to unenclosed moving parts such as beaters.	B
Overspeed prevention above a particular speed for those appliances where operation above that speed would expose users or bystanders to a substantial risk of injury due to the disintegration of moving parts or accessories as indicated in the end-product standard due to unenclosed moving parts such as beaters.	B
For appliances with output speed increases that do not meet the condition above.	Not a SCF
Prevent exceeding a thermal limit as defined in Section 9 of UL 2595 / CSA C22.2 No. 0.23.	A
Prevent self-resetting as required by the end-product standard or for appliances where unexpected operation exposes users or bystanders to a substantial risk of injury as identified in the end-product standard due to unenclosed moving parts such as beaters.	B
Prevent unwanted wetting of uninsulated live parts as defined in Clause 5.12 of this end-product standard (e.g. electronic float sensor).	C
Prevent operation under conditions of moisture leakage.	B

Table 31
Additional safety-critical functions (SCFs) for automatic battery-powered vacuum cleaners

(See Clause [7.16](#))

Type and purpose of SCFs	Minimum performance level (PL)
Power OFF switch to turn the vacuum off.	B
Stop control that stops the movement of accessible moving parts capable of causing injury within one second when the vacuum is lifted from the surface being cleaned.	B
Edge control that senses a critical edge and prevents the vacuum from falling off the cleaning surface (e.g., stairways). When the vacuum reaches the critical edge, it shall either stop, or move away from the edge and continue its normal vacuuming operation.	B
Obstruction control that senses obstructions and prevents accessible moving parts capable of causing injury from inadvertently coming in contact with persons or their body parts (e.g., fingers, toes, hair, etc.). When the vacuum reaches an obstruction, it shall either stop, or move away from the obstruction and continue its normal vacuuming operation.	B
Battery low voltage control that disables the operation of the vacuum when the battery is discharged to a voltage level in which the SCF controls above cannot function as intended.	B

Table 32
Requirements not applicable for battery-powered appliances

(See Clause [7.2\(b\)](#))

Title	Clause
Scope	1.6
General	2.1.2 and 2.1.3
Enclosures	4.2.1.5 – 4.2.1.8 , 4.2.2 , 4.2.3.6 , and 4.2.5
Supply connections	4.5.1 and 4.5.5
Internal wiring and external interconnections	4.7.4
Electrical insulation	4.8
Motors	4.9
Switches, relays, and similar controls	4.10
Controls – End product test parameters	4.11
Capacitors	4.12
Lampholders	4.13
Receptacles	4.14
Spacings	4.15
Grounding and bonding	4.16
Protective devices	4.17.1
Heating elements – Vacuum with steam-cleaning attachment	4.18
Thermal links	4.19
Protection against injury to persons	4.20.4 , 4.20.8 , and 4.20.9
Tests, General	5.1.2 and 5.1.3
Normal loads	5.2
Leakage current	5.3 – 5.5

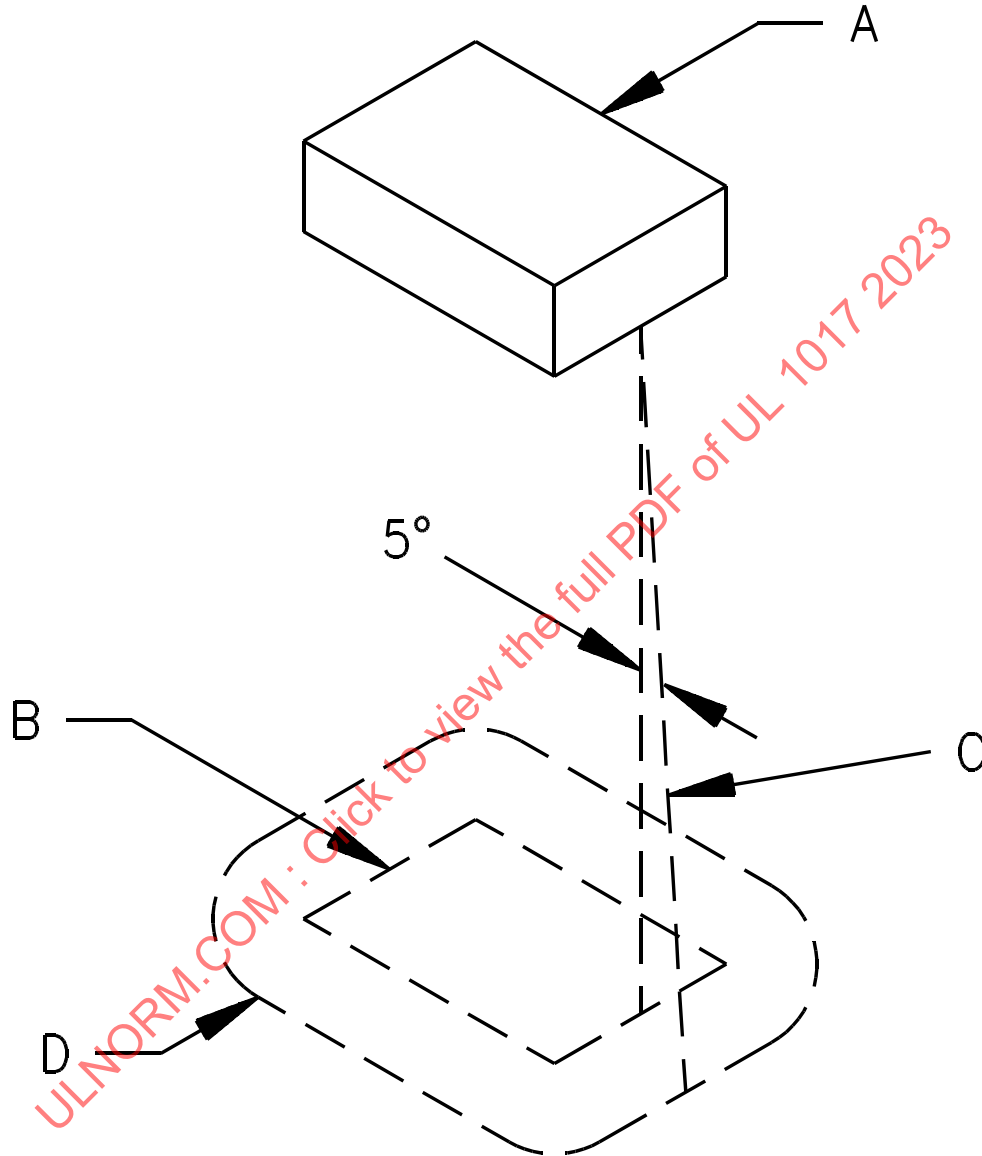
Table 32 Continued on Next Page

Table 32 Continued

Title	Clause
Starting current	5.6
Rating	5.7
Temperature	5.8
Severe operating conditions	5.9
Abnormal operation	5.10
Dielectric voltage-withstand test	5.11
Resistance to moisture	5.12.9
Strain relief	5.14
Switches, relays, and similar controls	5.15
Cord reel flexing	5.16
Power-supply cord flexing	5.17
Internal wiring and interconnecting cord flexing	5.18.1 (c) and (d)
Polymeric enclosure parts	5.21.1 – 5.21.7 , 5.21.9 and 5.21.10
Polymeric materials used as structural support	5.22
Thermoplastic motor insulation systems	5.24
End-product arc resistance	5.25
Abnormal overload	5.26
Glow-wire end-product test	5.27
Blower cleaner impeller tests	5.28
Integral insulation	5.29
Testing of temperature control devices used in a vacuum with a steam-cleaning attachment	5.30
Mechanical valve endurance test	5.31
General purpose transformers	5.32
Marking	11.1.2 , 11.1.3 , 11.1.6 , 11.1.7 , 11.3.1 – 11.3.12 , 11.3.14 , 11.3.16 , 11.4.7 , 11.4.14 , 11.4.19 , 11.4.22 – 11.4.24 , and 11.4.26
Instruction Manual	12.2.10 , 12.2.11 , 12.3 , 12.4 , 12.5.2 – 12.5.6 , 12.5.8 – 12.5.10 , and 12.5.12 – 12.5.16

Figure 1
Location and extent of barrier

(See Clause [4.2.3.4](#))



EB120A

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded, and will consist of the unshielded portion 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. When moving, the line is always (1) tangent to the component, (2) 5° from the vertical, and (3) oriented so 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.

Figure 2
Articulated accessibility probe

(See Clauses [4.2.5.1](#), [4.2.5.3](#), [4.5.2.2](#) and [4.20.3.1](#))

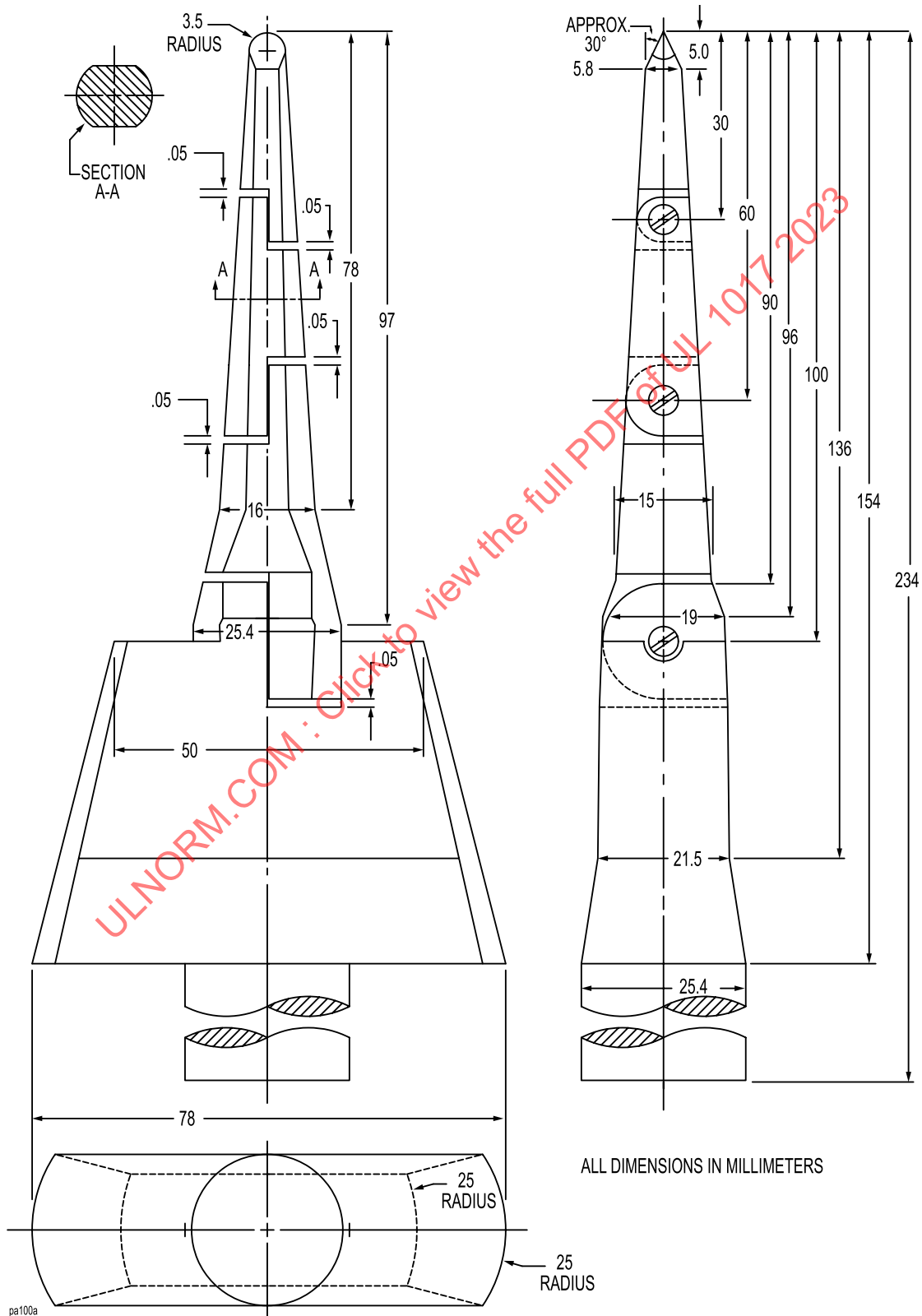


Figure 3
Straight probe

(See Clauses [4.2.5.2](#) and [4.2.5.3](#))

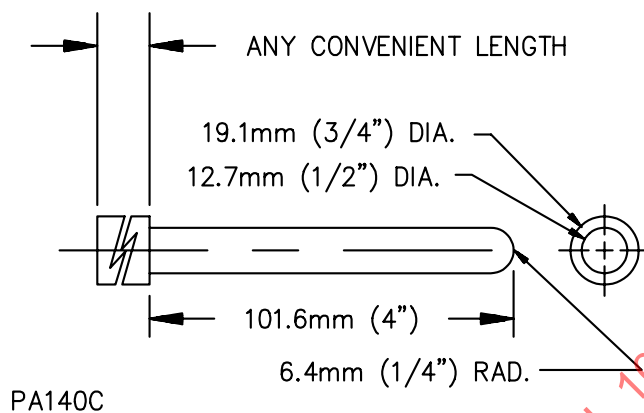
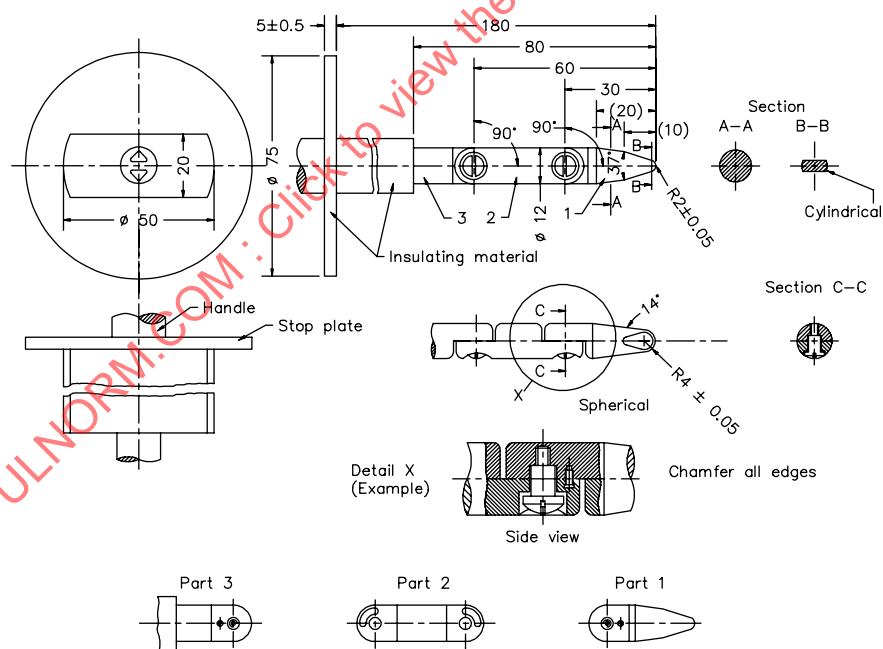


Figure 4

International Electrotechnical Commission, (IEC) articulate accessibility probe with stop plate

(See Clauses [4.2.5.2](#), [4.2.5.3](#) and [4.20.3.1](#))

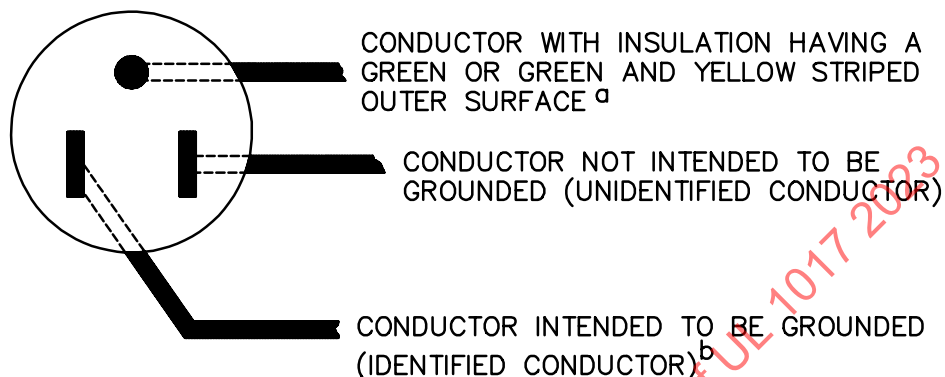


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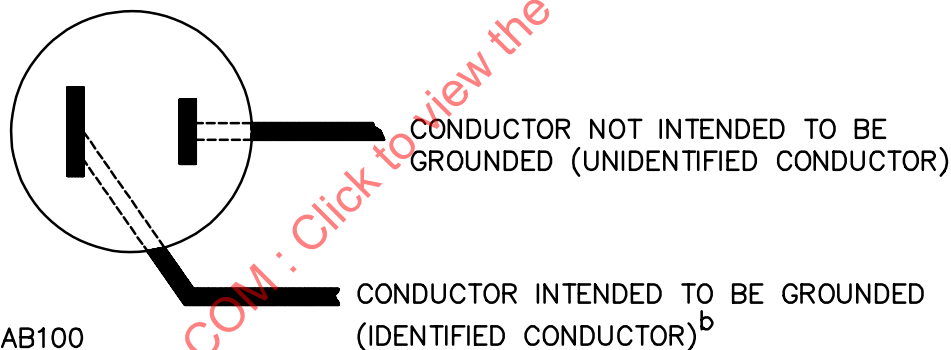
Figure 5
Connections to attachment plug

(See Clause [4.5.1.8](#) and [Table 3](#))

CONNECTIONS OF CORD CONDUCTORS TO GROUNDING – TYPE
ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



CONNECTIONS OF CORD CONDUCTORS TO POLARIZED
ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)

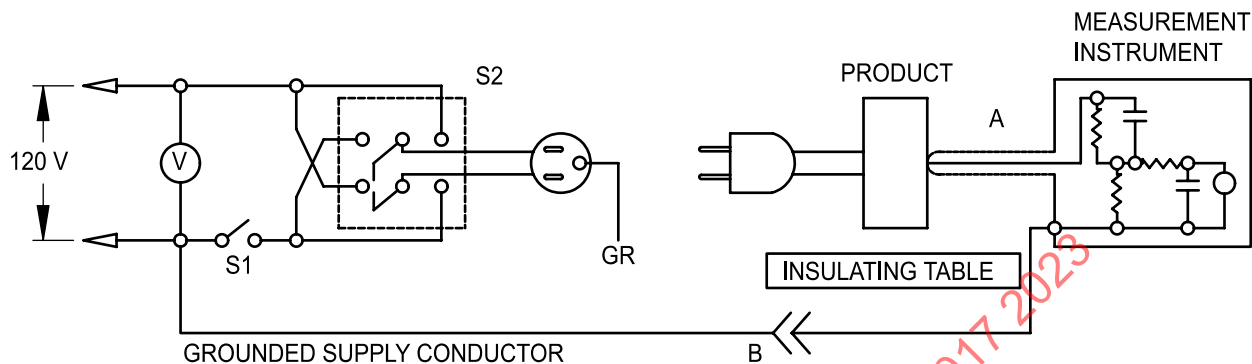


^a The blade to which the green conductor is connected may have a U-shape instead of a circular cross section.

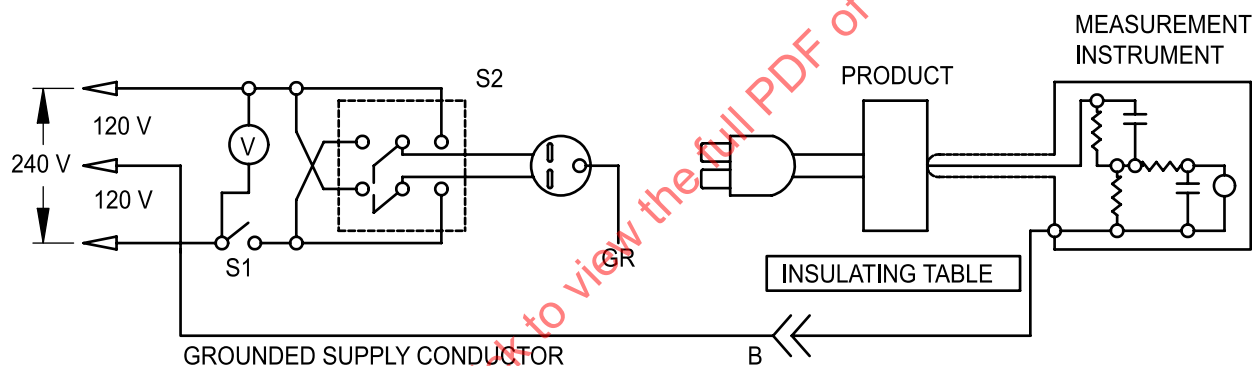
^b Signifies a conductor identified in accordance with [Table 3](#).

Figure 6
Leakage current measurement circuits

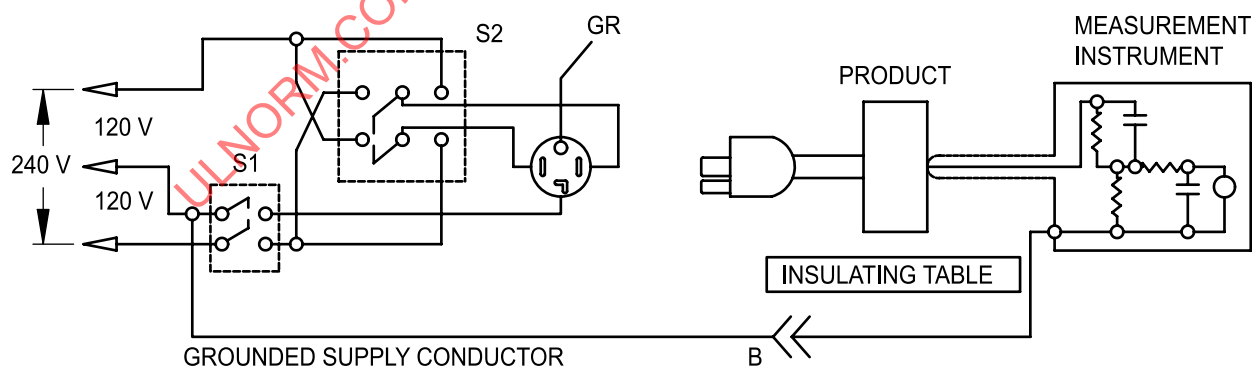
(See Clauses 5.3.5 and 5.12.4.1)



Product intended for connection to a 120-volt power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

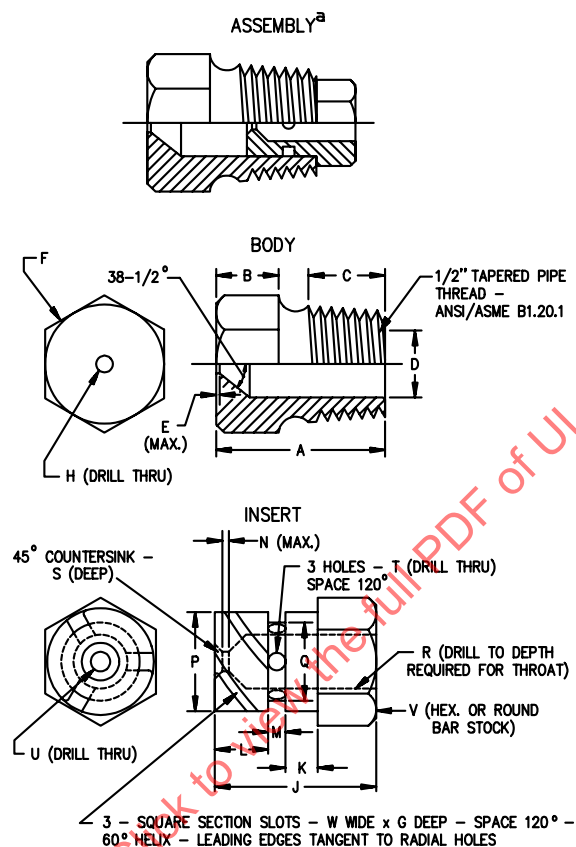
su0013

A – Probe with shielded lead.

B – Separated and used as clip when measuring currents from one part of product to another.

Figure 7
Spray head

(See Clause 5.12.1.3)



RT100C

Item	mm	(in)	Item	mm	(in)
A	31.0	(1-7/32)	N	0.80	(1/32)
B	11.0	(7/16)	P	14.61	(0.575)
C	14.0	(9/16)	Q	14.63	(0.576)
D	14.68	(0.578)	R	11.51	(0.453)
E	14.73	(0.580)	S	11.53	(0.454)
F	0.40	(1/64)	T	6.35	(1/4)
G	c	c	U	0.80	(1/32)
H	1.52	(0.06)	V	2.80	(No. 35) ^b
J	5.0	(No. 9) ^b	W	2.50	(No. 40) ^b
K	18.3	(23/32)		16.0	(5/8)
L	3.97	(5/32)		1.52	(0.06)
M	6.35	(1/4)			
	2.38	(3/32)			

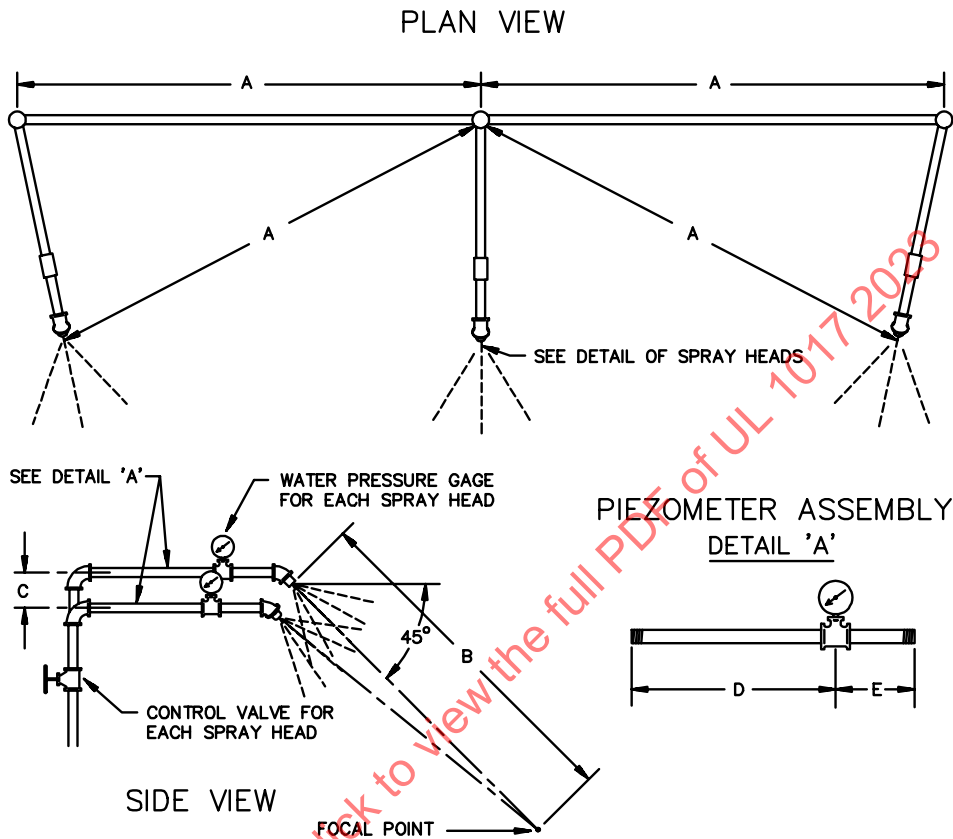
^a Nylon Rain-Test Spray heads are available from Underwriters Laboratories Inc.

^b ANSI B94.11M Drill size

^c Optional - To serve as wrench grip.

Figure 8
Spray head pipe rack

(See Clause 5.12.1.3)

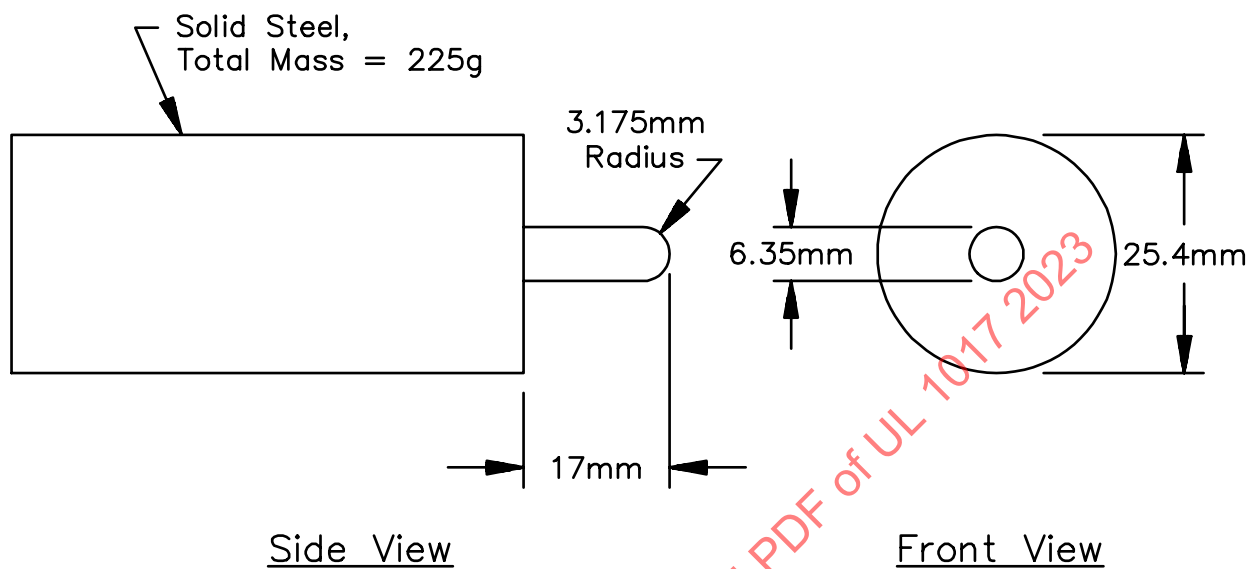


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Item	mm	(in)
A	710	(28)
B	1400	(55)
C	55	(2-1/4)
D	230	(9)
E	75	(3)

Figure 9
Impactor

(See Clause [5.19.4.1](#))



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Figure 10
Location of applicators for crush-resistance test

(See Clause [5.21.9.2](#))

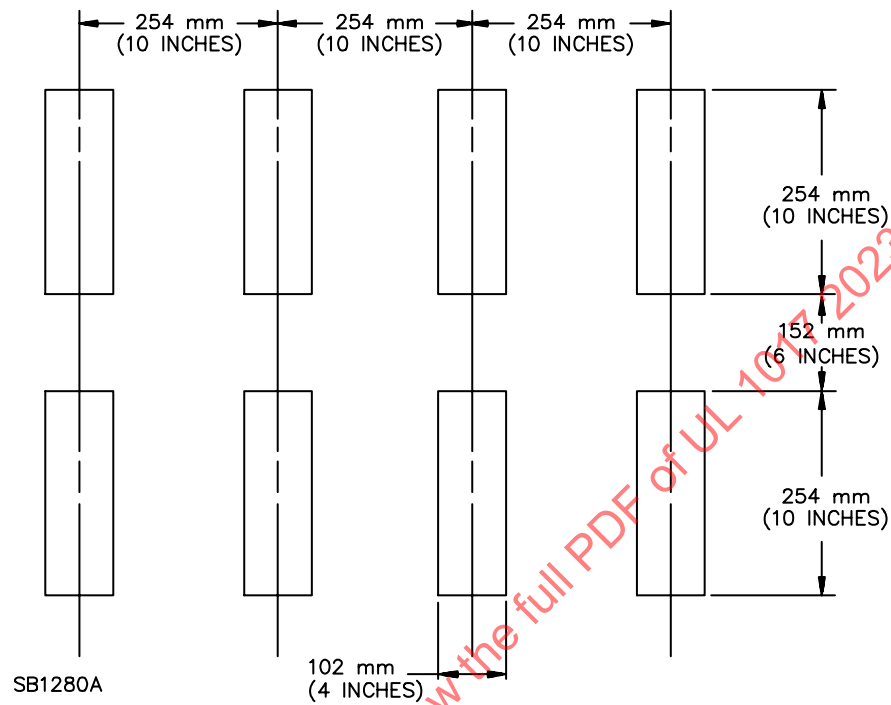
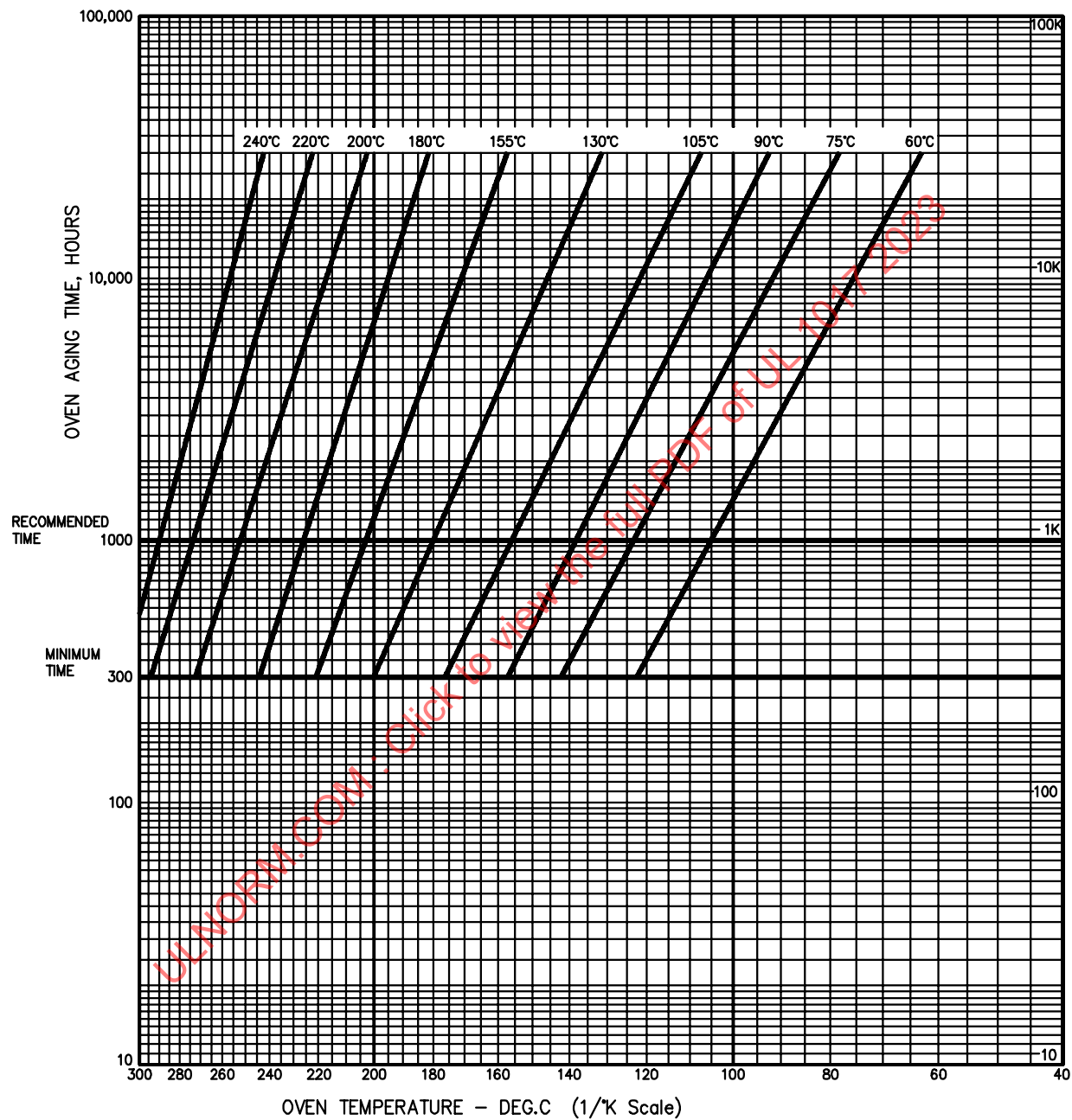


Figure 11

Conditioning time versus oven temperature for temperature index of adhesives

(See Clause 5.23.3.1)



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