



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

(Title Page Reprinted: March 14, 2023)

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ANSI/UL 1017-2017 (R2023)

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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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 shampoos, 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

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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

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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

UL Standards

UL 44

Thermoset-Insulated Wires and Cables

UL 62

Flexible Cord and Cables

UL 66

Fixture Wire

UL 83

Thermoplastic-Insulated Wires and Cables

UL 94

Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 101

Leakage Current for Appliances

UL 157

Gaskets and Seals

UL 224

Extruded Insulating Tubing

UL 244A

Solid-State Controls for Appliances

UL 310

Electrical Quick-Connect Terminals

UL 353

Limit Controls

UL 355

Cord Reels

UL 486A-486B

Wire Connectors

UL 486C

Splicing Wire Connectors

UL 486E

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

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Industrial Trucks, Internal Combustion Engine-Powered

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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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Cord Sets and Power-Supply Cords

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Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment

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Temperature-Indicating and -Regulating Equipment

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UL 943

Ground-Fault Circuit-Interrupters

UL 943B

Appliance Leakage-Current Interrupters

UL 969

Marking and Labeling Systems

UL 1004-1

Rotating Electrical Machines – General Requirements

UL 1004-2

Impedance Protected Motors

UL 1004-3

Thermally Protected Motors

UL 1004-7

Electronically Protected Motors

UL 1012

Power Units Other Than Class 2

UL 1030

Sheathed Heating Elements

UL 1053

Ground-Fault Sensing and Relaying Equipment

UL 1054
Special-Use Switches

UL 1059
Terminal Blocks

UL 1077
Supplementary Protectors for Use in Electrical Equipment

UL 1283
Electromagnetic Interference Filters

UL 1310
Class 2 Power Units

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

UL 1446
Systems of Insulating Materials – General

UL 1449
Surge Protective Devices

UL 1565
Positioning Devices

UL 1577
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.