UL 1017

STANDARD FOR SAFETY

Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines

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

Eleventh Edition, Dated March 26, 2025

Summary of Topics

This new Eleventh edition of ANSI/UL 1017 dated March 26, 2025 includes the following changes in requirements: Double insulation: Waiving overload test on motors moving air only; Addition of requirements for pin and sleeve terminals; Clarification of allowance for 18-inch cord length; Button-cell lithium batteries; Updates for motor polymeric motor insulation systems; Drop impact test for removable reservoirs; Suitability of motor protectors operating during abnormal conditions; Removal of polarization instructions from the Important Safeguards for products with 18 inch cord; Interlock endurance test; Attachment identification marking; General purpose transformer testing; Update safety critical function tables due to revision to UL 2595; Clarify location for blocked inlet condition of the severe conditions test (air inlet or end of hose); Clarification of defeated component test for polymeric fluid handling components for appliances with attachments containing liquids; Clarification of the thermal aging requirement of 5.21.10; Corrections and clarification of the PFHC requirements of 5.12.8 and the flowchart (Figure F.1) from Annex F Clarification of switches for steam cleaning attachments; Update attachment plug rating to align with appliance rating; Update supplier list of test carpet; Add UL 840 as alternative to meeting spacing requirements; 550 °C Glow Wire Test in place of HB; PTI test as alternative to CTI; Cord length of household extraction type floor cleaners; Ash vacuum cleaners; Replace "dielectric voltage-withstand" with "electric strength"; Revise requirement for grounding and bonding per CSA comment; Eliminate exceptions; Updated references to UL, CSA and IEC standards; Clarification of non-user-replaceable LED light sources in 4.13.5; Correction to Table 5.3; Clarification of the Strength of handles test; Utility Vacuum Cleaner Definition/Instructions; Operation of protective devices during normal operation; Normal Operation Duty Cycle for products with a timer; Mechanical Hazard proposal; Mechanical Valve Operation for input test; Cord and conduction AWG units in Table 12.1 and Table 4.9; Motors without a horsepower rating; Battery-operated appliances – Disconnection before cleaning or servicing; Waiving the stalled rotor condition of 5.21.7 for electronically commutated motors; Clarifying the compliance criteria for flooding of live parts test of 5.12.5; Allow digital manuals; Testing on hard surfaces; Update the Scope to reflect the products covered; Use of mean flow in lieu of mean wattage for normal operation; Class H insulation temperature limits; Wire color coding; Updated reference to information technology equipment standards; Attachment plug rating for steam cleaners; Robotic floor care; Docking Station Supply Cord Type and Length; and Correction to conversion in B3.2.

The requirements are substantially in accordance with Proposal(s) on this subject dated May 3, 2024 and November 8, 2024.

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CSA C22.2 No. 243:25
Seventh Edition

ULSE Inc.
UL 1017
Eleventh Edition

Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines

March 26, 2025

Approved American National Standard

ANSI/UL 1017-2025

Commitment for Amendments

This Standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or ULSE at anytime. Revisions to this Standard will be made only after processing according to the standards development procedures of CSA Group and ULSE. CSA Group and ULSE will issue revisions to this Standard by means of a new edition or revised or additional pages bearing their date of issue.

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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 Eleventh Edition. The most recent designation of ANSI/UL 1017 as a Reaffirmed American National Standard (ANS) occurred on March 26, 2025. 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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CONTENTS

PREFACE

This is the harmonized CSA Group and ULSE standard for Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines. It is the seventh edition of CSA C22.2 No. 243, and the eleventh edition of UL 1017. This edition of CSA C22.2 No. 243 supersedes the previous edition(s) published in 2015 and 2017. This edition of UL 1017 supersedes the previous edition(s) published in 2017.

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 Subcommittee 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. This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

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, and to household use floor sweepers and floor finishing machines to be employed in accordance with CSA C22.1, Canadian Electrical Code, Part I, and NFPA 70.

1.2 These requirements cover:

a) Vacuum cleaners, including central vacuum cleaners, ash vacuum cleaners and vacuum cleaners with steam cleaning attachments, for:

1) Household or commercial use;

2) Marine or RV installation;

3) Portable, stationary or fixed appliances;

4) Wet or dry pick-up;

5) Indoor or outdoor use;

6) Coin-operation; and

7) Battery-operation, including automatic rechargeable vacuum cleaners

b) Blower cleaners for:

1) Household or commercial use;

2) Indoor or outdoor use; and

3) Battery-operation

c) Floor sweepers for:

1) Household use; and

2) Battery-operation

d) Floor finishing machines including floor polishers, floor scrubbers, floor sanders, rug shampooers, extraction-type floor cleaning machines, rug and floor washers and similar machines, for:

1) Household use;

2) Indoor or outdoor use; and

3) Battery-operation

e) Current-carrying hoses and wall valves for:

1) Household use;

2) Wet or dry pick-up; and

3) Indoor use

f) Battery-operated cleaners as noted in (a) – (d), including:

1) automatic battery-powered cleaners for:

i) Household or commercial use;

ii) Units with a mass of 20 kg (44 lbs) or less, not including the docking station; and

iii) Indoor use only

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 This Standard does not apply to:

a) Internal-combustion engine powered floor cleaning machines for industrial/commercial use with or without traction drive, such as floor buffers, scrubbers, sweepers, spray extraction machines, and polishers, (UL/ULC (ORD) 558, UL/CSA 60335-2-67, UL/CSA 60335-2-68, UL/CSA 60335-2-72;

b) Battery-operated floor cleaning machines for industrial/commercial use with traction drive; (UL 583, UL/CSA 60335-2-72);

c) Commercial robotic floor treatment machines (CSA/ANSI C22.2 No. 336);

d) Commercial floor finishing machines (UL 561, CSA C22.2 No. 10, UL/CSA 60335-2-67, UL/CSA 60335-2-68, UL/CSA 60335-2-72); and

e) Steam cleaners (CSA C22.2 No. 64, CSA E60335-2-54, UL 499). For steam cleaners with suction, the vacuum function is covered by this Standard.

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

1.8 Specific constructions, tests, markings, guards, and the like are detailed for some common designs. Specific features and appliances not covered are to be given appropriate consideration. See Marking, Section 11.

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.

2.1.2 Unless otherwise specified within this Standard, a non-electrical attachment, such as a crevice tool, an upholstery brush, or the like, that has no driven parts need not be investigated. However if such an attachment is intended to facilitate a cleaning operation with the use of liquid and is intended for use with a dry pick up vacuum cleaner, it shall be investigated for use with the appliance.

2.1.3 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, 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, 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 CSA C22.2 No. 182.1 and UL 1977.

d) The applicable Severe conditions (see 5.21.5) and Abnormal operation (see 5.21.7) tests shall be conducted with and without the electrical attachment connected to the appliance as intended.

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

2.1.5 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 4.2, 4.19.3, and 5.21 without the container attached. See also 11.1.8, 11.4.27, 12.2.7(m), and 12.5.19.

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 5.12.8.1.4, 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.

2.2.2 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 2.1.1, 11.1.8, 12.5.7, and 12.7.

2.2.3 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 2.1.1, 11.1.8, 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 in Section 12, Instruction Manuals.

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 4.3.2, 4.4.5, 4.5.5.1.9, 5.19.6, 5.19.7, and 5.19.8, 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 Referenced publications

2.7.1 For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved. For dated references to Standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the Standard was approved.

2.7.2 For products intended for use in Canada, general requirements are given in CSA C22.2 No. 0.

ANSI B94.11M

ASME B94.11M, *Twist Drills*

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 F655, *Standard Specification for Test Carpets and Pads for Vacuum Cleaner Testing*

CFR 21, *Performance Standards for Light-Emitting Products, Part 1040, Chapter 1, Subchapter J, Radiological Health*

CSA C22.1, *Canadian Electrical Code, Part I*

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.4, *Bonding of Electrical Equipment*

CSA C22.2 No. 0.15, *Adhesive Labels*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 0.2, *Insulation Coordination*

CSA C22.2 No. 0.23, *General Requirements for Battery-Powered Appliances*

CSA C22.2 No. 5, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures*

CSA C22.2 No. 8, *Electromagnetic Interference (EMI) Filters*

CSA C22.2 No. 10, *Electric Floor Surfacing and Cleaning Machines*

CSA C22.2 No. 18.1, *Metallic Outlet Boxes*

CSA C22.2 No. 18.2, *Nonmetallic Outlet Boxes*

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

CSA C22.2 No. 18.5, *Positioning Devices*

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

CSA C22.2 No. 24, *Temperature-Indicating and Regulating Equipment*

CSA C22.2 No. 38, *Thermoset-Insulated Wires and Cables*

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

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

CSA C22.2 No. 43, *Lampholders*

CSA C22.2 No. 49, *Flexible Cords and Cables*

CSA C22.2 No. 55, *Special Use Switches*

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

CSA C22.2 No. 65, *Wire Connectors*

CSA C22.2 No. 66.1, *Low-Voltage Transformers – Part 1: General Requirements*

CSA C22.2 No. 66.2, *Low-Voltage Transformers – Part 2: General Purpose Transformers*

CSA C22.2 No. 66.3, *Low-Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

CSA C22.2 No. 72, *Heating Elements*

CSA C22.2 No. 75, *Thermoplastic-Insulated Wires and Cables*

CSA C22.2 No. 77, *Motors With Inherent Overheating Protection*

CSA C22.2 No. 100, *Motors and Generators*

CSA C22.2 No. 107.1, *General-Use Power Supplies*

CSA C22.2 No. 127, *Equipment and Lead Wires*

CSA C22.2 No. 144.1, *Ground-Fault Circuit-Interrupters*

CSA C22.2 No. 153, *Electrical Quick-Connect Terminals*

CSA C22.2 No. 158, *Terminal Blocks*

CSA C22.2 No. 182.1, *Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type*

CSA C22.2 No. 182.3, *Special Use Attachment Plugs, Receptacles, and Connectors*

CSA C22.2 No. 188, *Splicing Wire Connectors*

CSA C22.2 No. 190, *Capacitors and Power Factor Correction*

CSA C22.2 No. 197, *PVC Insulating Tape*

CSA C22.2 No. 198.1, *Extruded Insulating Tubing*

CSA C22.2 No. 198.3, *Coated Electrical Sleeving*

CSA C22.2 No. 210, *Appliance Wiring Material Products*

CSA C22.2 No. 223, *Power Supplies with Extra-Low-Voltage Class 2 Outputs*

CSA C22.2 No. 235, *Supplementary Protectors*

CSA C22.2 No. 248.1, *Low Voltage Fuses*

CSA C22.2 No. 248.14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

CSA C22.2 No. 248.5, *Low-Voltage Fuses – Part 5: Class G Fuses*

CSA C22.2 No. 250.13, *Light emitting diode (LED) equipment for lighting applications*

CSA C22.2 No. 270, *Arc fault protective devices*

CSA C22.2 No. 308, *Cord reels and multi-outlet assemblies*

CSA C22.2 No. 4248.1, *Fuseholders – Part 1: General Requirements*

CSA C22.2 No. 4248.9, *Fuseholders – Part 9: Class K*

CSA C22.2 No. 60320-1, *Appliance couplers for household and similar general purposes – Part 1: General requirements*

CSA 60335-2-67, *Household and Similar Electrical Appliances – Safety – Part 2-67: Particular Requirements for Floor Treatment Machines, for Commercial Use*

CSA 60335-2-68, *Household and Similar Electrical Appliances – Safety – Part 2-68: Particular Requirements for Spray Extraction Machines, for Commercial Use*

CSA 60335-2-27, *Household and Similar Electrical Appliances – Safety – Part 2-72: Particular Requirements for Floor Treatment Machines With or Without Traction Drive, for Commercial Use*

CSA C22.2 No. 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

CSA C22.2 No. 61058-1, *Switches for Appliances, Part 1: General Requirements*

CSA C22.2 No. 62841-1, Electric motor-operated hand-held tools, transportable tools and lawn and garden machinery – Safety – Part 1: General requirements

CSA E60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

CSA E60691, *Thermal-Links, Requirements and Application Guide*

CSA E60730-1, *Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements*

CSA E60730-2-9, *Automatic Electrical Controls for Household and Similar Use – Part 2: Particular Requirements for Temperature Sensing Controls*

CSA C22.2 No. 336, *Particular requirements for rechargeable battery-operated commercial robotic floor treatment machines with traction drives*

CRC C.1370, *Radiation Emitting Devices Regulations*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60320, *Appliance Couplers for Household and Similar General Purposes*

IEC 60417, *Graphical Symbols for Use on Equipment*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 62849, *Performance evaluation methods of mobile household robots*

IESNA RP-27.1, *Recommended Practice for Photobiological Safety for Lamps and Lamp Systems-General Requirements*

IESNA RP-27.3, *Recommended Practice for Photobiological Safety for Lamps – Risk Group Classification and Labeling*

ISO 216, *Writing paper and certain classes of printed matter – Trimmed sizes – A and B series, and indication of machine direction*

ISO 7000, *Graphical Symbols for Use on Equipment – Registered Symbols*

ISO 7000-1641

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 WD 6, *Wiring Devices*

NFPA 70, *National Electrical Code*

TIL A-37, *Interim Certification Requirements for Switches Used in Tools*

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 248-1, *Low Voltage Fuses*

UL 248-14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

UL 248-5, *Low-Voltage Fuses – Part 5: Class G Fuses*

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*

UL 561, *Floor-Finishing Machines*

UL 583, *Electric-Battery-Powered Industrial Trucks*

UL 635, *Insulating Bushings*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

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

UL 758, *Appliance Wiring Material*

UL 796, *Printed Wiring Boards*

UL 810, *Capacitors*

UL 817, *Cord Sets and Power-Supply Cords*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 943, *Ground-Fault Circuit-Interrupters*

UL 943B, *Appliance Leakage-Current Interrupters*

UL 969, *Marking and Labeling Systems*

UL 969A, *Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products*

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 1059, *Terminal Blocks*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

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, 3rd edition, *General Requirements for Battery-Powered Appliances*

UL 2595, *General Requirements for Battery-Powered Appliances*

UL 4200A, *Products Incorporating Button Batteries or Coin Cell Batteries*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-9, *Fuseholders – Part 9: Class K*

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 60320-1, *Appliance couplers for household and similar general purposes – Part 1: General requirements*

UL 60335-2-67, *Household and Similar Electrical Appliances – Safety – Part 2-67: Particular Requirements for Floor Treatment Machines, for Commercial Use*

UL 60335-2-68, *Household and Similar Electrical Appliances – Safety – Part 2-68: Particular Requirements for Spray Extraction Machines, for Commercial Use*

UL 60335-2-27, *Household and Similar Electrical Appliances – Safety – Part 2-72: Particular Requirements for Floor Treatment Machines With or Without Traction Drive, for Commercial Use*

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 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*

UL 61058-1-6, *Switches for Appliances – Part 2-6: Particular Requirements for Switches Used In Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery*

UL 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

UL 62841-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 1: General Requirements*

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, 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 ASH VACUUM CLEANER – A vacuum cleaner intended to vacuum cold ash from fireplaces, chimneys, ovens, ash-trays and similar places of ash accumulation.

3.7 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.

3.8 AUTOMATIC BATTERY-POWERED FLOOR CLEANER (ROBOT FLOOR CLEANER) – Floor cleaner intended for unattended automatic operation and capable of autonomous motion. The automatic floor cleaner consists of a mobile part and may have a docking station or other accessories to assist its operation. These appliances may also be known as Robot Floor Cleaners.

3.9 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.

3.10 BASIC INSULATION – The insulation in contact with live parts to provide basic protection against the risk of electric shock.

3.11 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operating 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.

3.12 CONTROL, MANUAL – A device that requires direct human interaction to activate or reset the control.

3.13 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.

3.14 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.

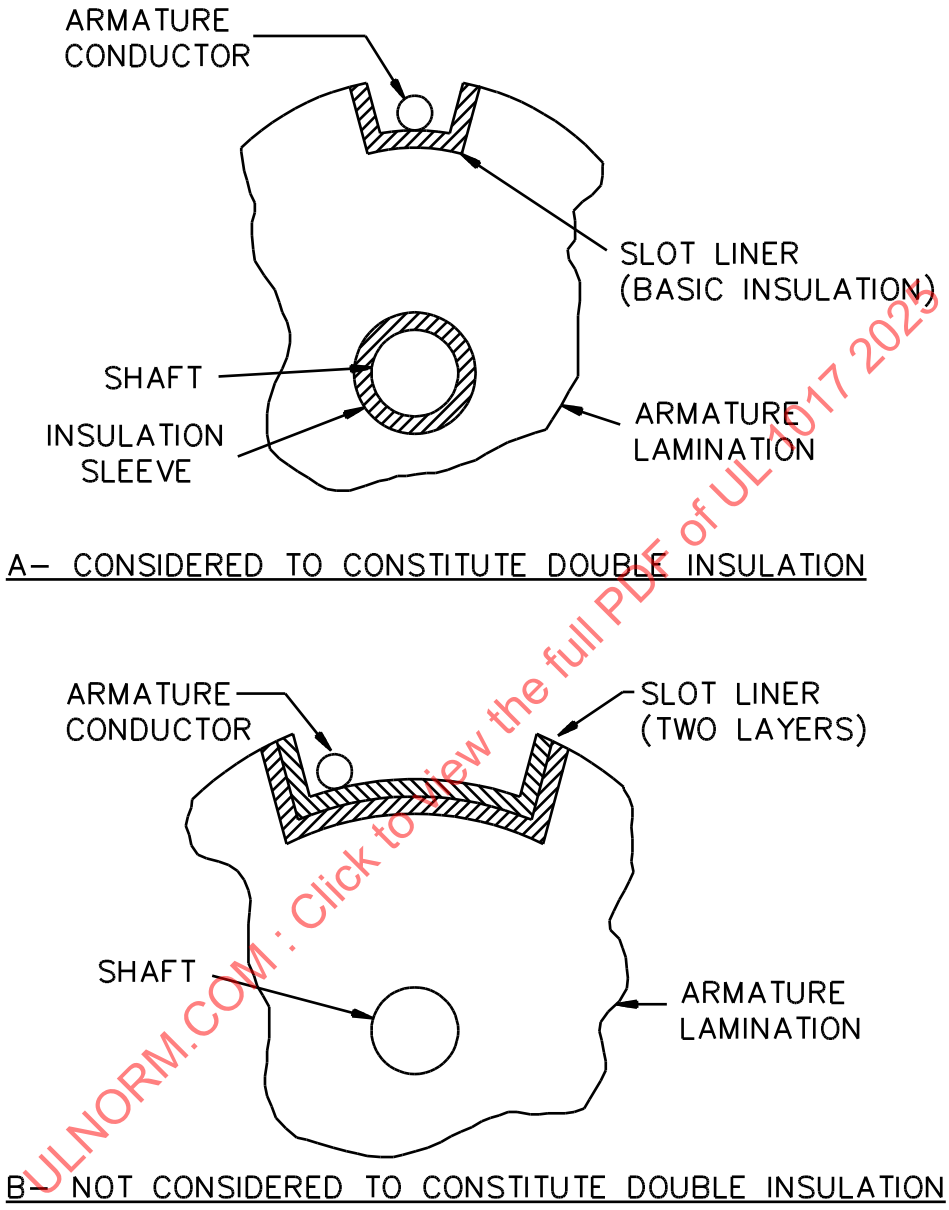
3.15 CORD CONNECTOR – A female contact device wired on flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or, as an appliance coupler, to an equipment inlet.

3.16 DOCKING STATION (BASE UNIT) – Unit that may provide manual or automatic battery charging facilities, dust removal from the mobile part (s), data processing facility or other support functions for use with automatic battery-powered floor cleaners.

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 3.1.

Figure 3.1

Examples Illustrating Double Insulation



3.18 DUST EXTRACTOR – A stationary or portable vacuum cleaner specifically designed to be connected to dust-generating machines

3.19 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.

3.20 FIXED APPLIANCE – Any appliance that is intended to be permanently connected electrically to the wiring system.

3.21 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.

3.22 HARD SURFACE – Any surface that is not carpeted or upholstered.

3.23 HAZARDOUS MOVING PART – A moving part that is capable of causing injury to persons.

3.24 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.

3.25 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.

3.26 LIVE PART – A part that is conductively connected to a line-voltage circuit.

3.27 MEASUREMENT INDICATION UNIT (MIU) – The unit used in measuring leakage current as defined in UL 101.

3.28 MOTORIZED NOZZLE – An accessory containing a motor that is attached to the end of the hose or wand. It may be provided with power from a vacuum cleaner or, for a motorized nozzle intended for use with a central vacuum system, directly from the supply outlet or with a battery.

3.29 NONCURRENT-CARRYING METAL PART – A metal or other electrically conductive part, accessible or inaccessible, that is not conductively connected to a live part.

3.30 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.

3.31 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 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 hp;

b) Stationary appliances with a motor greater than 1/8 hp; or

c) Motor controlling accessible hazardous moving part(s).

3.32 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.

3.33 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.

3.34 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.

3.35 STATIONARY APPLIANCE – Any 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.

3.36 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.

3.37 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.

3.38 UTILITY VACUUM CLEANER – A portable, floor-supported, cord-connected dry or wet/dry vacuum cleaner intended primarily for a work area, such as use in domestic garages, shops and construction sites.

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 4.1.2. Other components may comply with this Standard or comply with the component standards referenced throughout this 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.

4.1.1.4 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 CSA 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) CSA C22.2 No. 223 and UL 1310;

b) CSA C22.2 No. 60950-1 and UL 60950-1, with a "Class 2", or limited power source (LPS) output; or

c) CSA C22.2 No. 62368-1 and UL 62368-1, with a Class 2 or limited power source (LPS) output.

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

a) CSA C22.2 No. 107.1 and UL 1012; or

b) CSA C22.2 No. 60950-1 and UL 60950-1; or

c) CSA C22.2 No. 62368-1 and UL 62368-1.

4.1.2.4 Printed wiring boards, including the coatings, shall comply with CSA 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 CSA C22.2 No. 0.17 and UL 746C.

4.1.2.5 A printed-wiring board in an extra-low voltage, non-safety circuit is not required to comply with the bonding requirements in CSA 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.

4.1.2.6 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 5.11 of this end product standard.

4.1.2.7 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 5.11 of this end product standard.

4.1.2.8 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.

4.1.2.9 Except as specified in 4.1.2.10, general-purpose transformers shall comply with CSA C22.2 No. 66.1 and UL 5085-1, and CSA C22.2 No. 66.2 and UL 5085-2.

4.1.2.10 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 4.1.2.9. See 5.31.

4.1.2.11 Class 2 and Class 3 transformers, other than those located in an extra-low voltage circuit that does not involve a risk of fire or personal injury, shall comply with CSA C22.2 No. 66.1 and UL 5085-1, and CSA C22.2 No. 66.3 and UL 5085-3.

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 Except as specified in 4.2.1.3 and 4.2.1.4, 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.

4.2.1.3 Metal of a lesser thickness than in 4.2.1.2, 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.

4.2.1.4 Metal of a lesser thickness than in 4.2.1.2, may be employed if it complies with the physical abuse tests in 5.19.

4.2.1.5 Except as specified in 4.2.1.6, 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).

4.2.1.6 An area that is relatively small or a surface that is curved or otherwise reinforced need not comply with 4.2.1.5 if it complies with the physical abuse tests in 5.19.

4.2.1.7 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.

4.2.1.8 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 5.21 and shall have a flammability rating or comply with the testing as specified below:

a) For a portable attended, household appliance:

1) Minimum flammability rating of HB, or HBF for foamed materials, in accordance with CSA C22.2 No. 0.17 and UL 94;

2) Needle flame test in accordance with CSA C22.2 No 0.17;

3) 12 mm or 20 mm (3/4 inch) flame test in accordance with UL 746C;

4) Glow-wire test at 550 °C in accordance with UL 746C;

5) Minimum 550 Glow wire flammability index (GWFI) in accordance with IEC 60695-2-12; or

6) Minimum 575 Glow wire ignitability temperature (GWIT) in accordance with IEC 60695-2-13.

b) For other portable appliances:

1) Minimum flammability rating of V-2

2) Needle flame test in accordance with CSA C22.2 No. 0.17; or

3) 12 mm or 20 mm (3/4 inch) flame test in accordance with UL 746C.

c) For a stationary or fixed appliance;

1) Minimum 5VA in accordance with CSA C22.2 No. 0.17 and UL 94; or

2) 127 mm (5 inch) flame test in accordance with UL 746C.

4.2.1.9 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 be subjected to the mold stress-relief distortion test, 5.21.3, and the impact test, 5.21.4 and shall comply with 4.2.1.8(a).

4.2.1.10 The requirements of 4.2.1.8, 4.2.1.9, 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.

4.2.1.11 With respect to the end-product flame tests referenced in 4.2.1.8, 4.2.1.9, 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 4.2.1.8 and 4.2.1.9, 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 comply with 4.2.1.8(a)

4.2.2.2 The requirements of 4.2.2.1 are not applicable to small parts whose maximum volume does not exceed 2 cm^3 (0.12 in^3).

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 3.7 and 3.30.

4.2.3.2 The requirement in 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

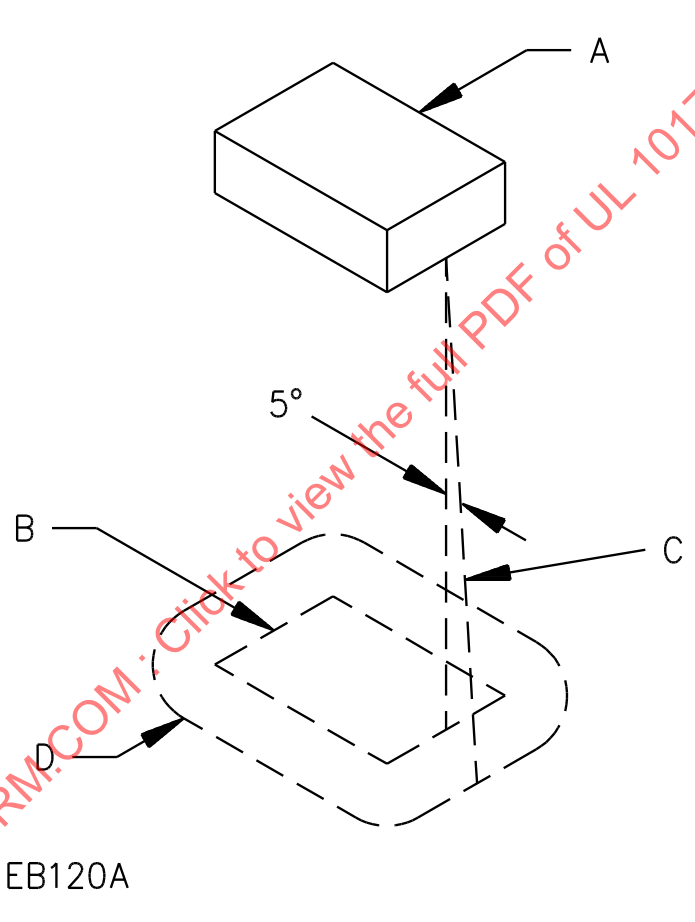
b) Under wiring, unless there is no evidence of a risk of fire as a result of the tests in Section 5.

4.2.3.3 Except for the terminals, a switch, a relay, a solenoid, or the like in an appliance as specified in 4.2.3.1 shall be individually and completely enclosed unless malfunction of the component would not result in a risk of fire or there are no openings in the bottom of the appliance.

4.2.3.4 The barrier mentioned in 4.2.3.2 shall be located as illustrated in Figure 4.1, 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.

Figure 4.1

Location and Extent of Barrier



A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded, and will consist of the unshielded 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.

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 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 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 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 5.23.

4.2.4.2 The requirement in 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 one of the following:

a) For an opening that has a minor dimension (see 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 4.2;

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 4.1.

c) 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 shall comply with (a) or (b) or 4.2.5.2.

Table 4.1
Minimum Acceptable Distance from an Opening to a Part that May Involve a Risk of Electric Shock

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 4.2.5.5.

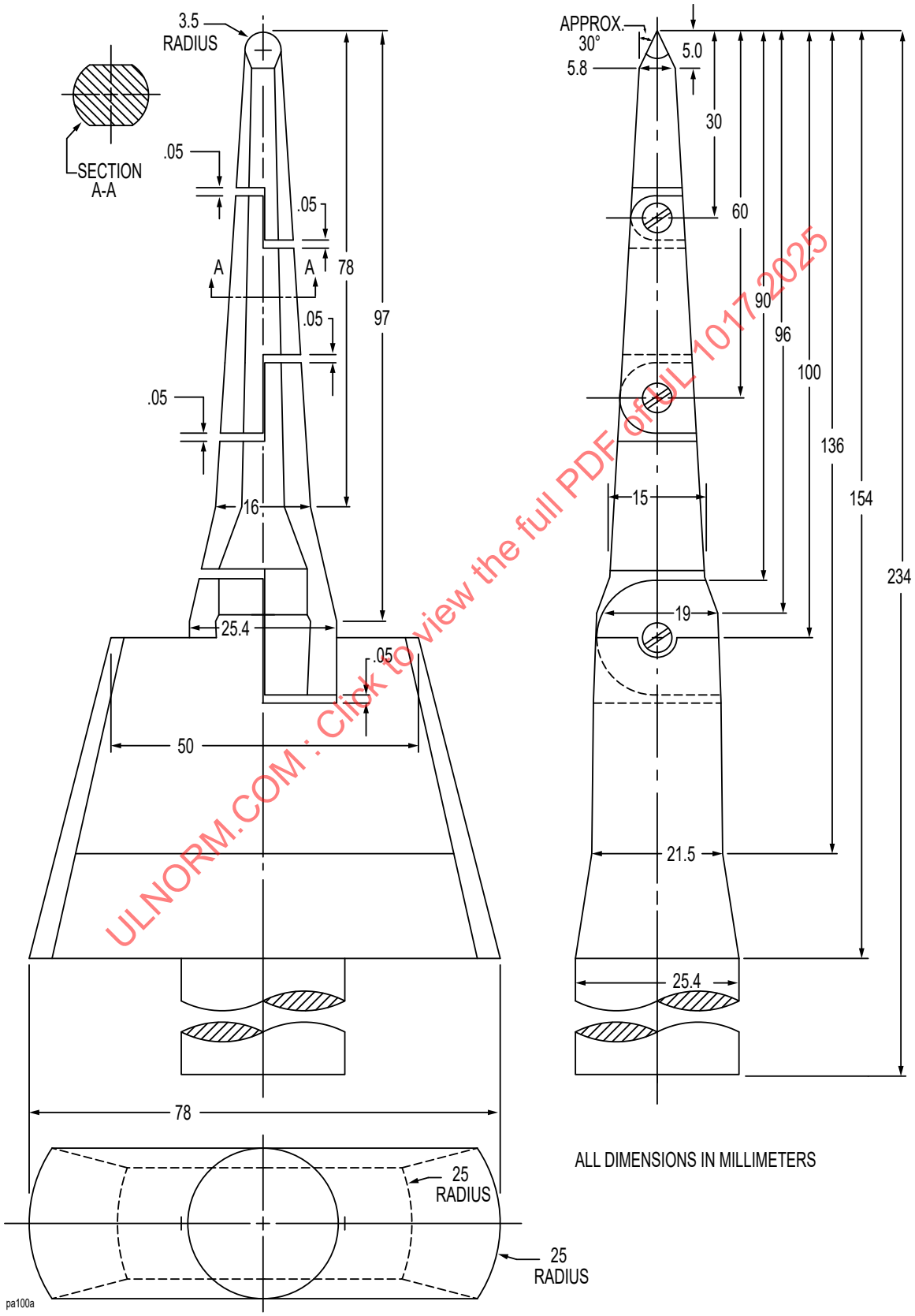
[b] Between 25.4 and 54.0 mm (1 and 2-1/8 in), interpolation shall be used to determine a value between values specified in this table.

[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).

Figure 4.2

Articulated Accessibility Probe



4.2.5.2 With respect to a part or wire as mentioned in 4.2.5.1 in an integral enclosure of a motor as mentioned in 4.2.5.1(c):

a) An opening that has a minor dimension (see 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 4.3;

2) An uninsulated live part cannot be contacted by the probe illustrated in Figure 4.4;

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 4.1.

Figure 4.3

Straight Probe

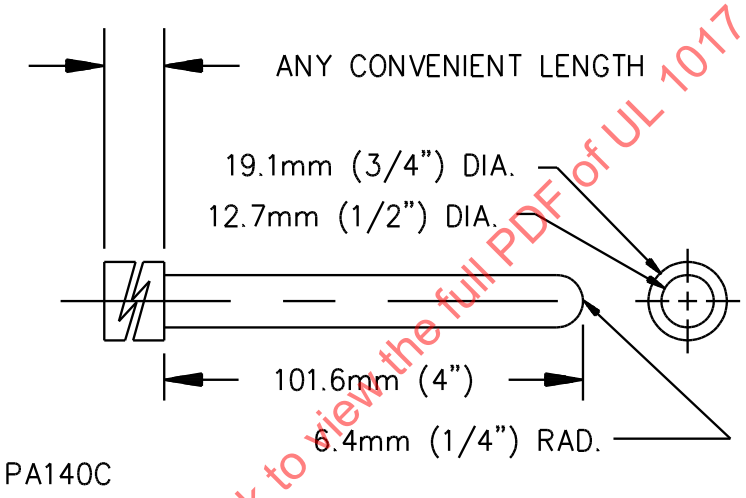
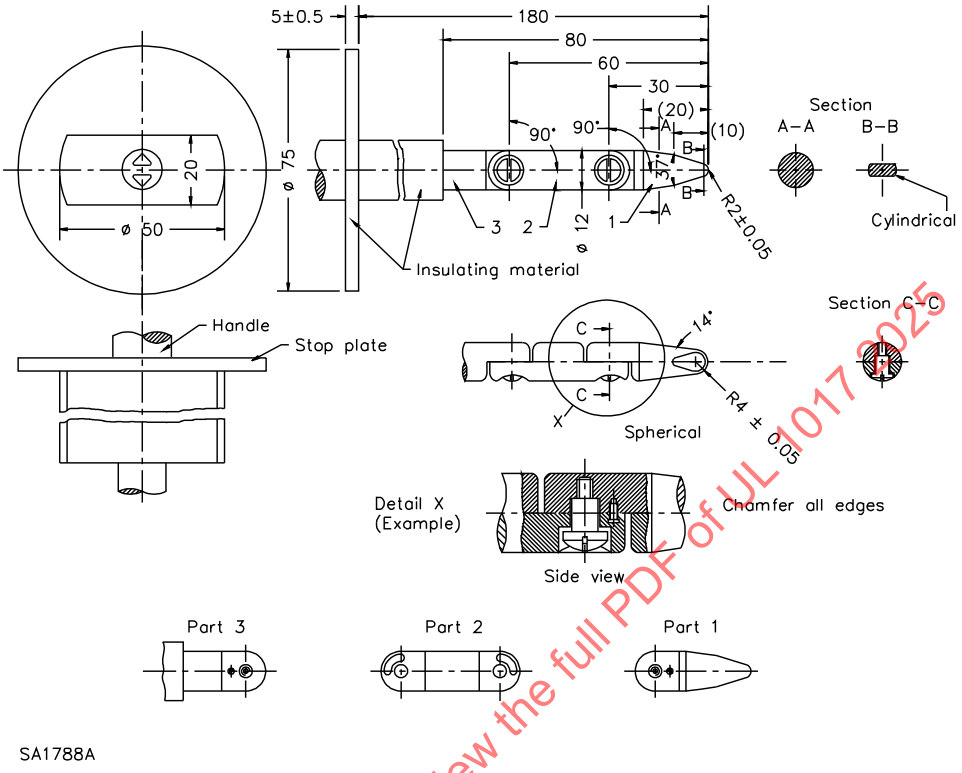


Figure 4.4

International Electrotechnical Commission, (IEC) Articulate Accessibility Probe with Stop Plate



4.2.5.3 The probes illustrated in Figure 4.2 – Figure 4.4 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 4.2 – Figure 4.4 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 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 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 CSA C22.2 No. 62368-1, UL 1676 and UL 62368-1;

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

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

4.2.6 Button batteries or coin cell batteries

4.2.6.1 To reduce the risk of injury due to battery ingestion, the battery compartment of an appliance or any accessory, such as a wireless control, incorporating one, or more replaceable coin cell batteries shall comply with UL 4200A, if the appliance or any accessory:

a) Is intended for use with one or more single cell batteries having a diameter of 32 mm (1.25 in) or less with a diameter greater than its height; and

b) Is intended for household use.

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 5.12.8.1.1 (a) and (b)]. Tubing subject to a pressure greater than 0.7 kg/cm^2 (10 psi) shall also comply with the tubing pressure test described in 5.12.8.4.

4.3.1.5 Fluid-handling tubing subject to a pressure of 0.7 kg/cm^2 (10 psi) or less is not required to be mechanically secured if the tubing complies with the tubing pressure test of 5.12.8.4.

4.3.1.6 Except as specified in 4.3.1.7, an appliance shall be completely assembled before being shipped from the factory.

4.3.1.7 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 4.5.5 or by plug and receptacle connection; and

e) The appliance is marked in accordance with 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 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.

4.3.3 Additional requirements for ash vacuum cleaners

4.3.3.1 The ash vacuum cleaner dirt receptacle (e.g. metal tank or pail) shall be sheet steel, minimum 0.6 mm (0.024 in.) thick. Thinner wall sections may be used if the material meets the requirements of the Physical abuse test of 5.19.3. The dirt receptacle shall not sustain damage that allows ash to escape the receptacle.

4.3.3.2 All nozzles, connectors and deflectors made out of non-metallic material upstream of the primary filter shall have a minimum flame rating of V-1 or shall comply with the needle flame test in accordance with CSA C22.2 No. 0.17.

4.3.3.3 The primary filter media used with ash vacuum cleaners shall comply with one of the following:

a) Glow-wire test at 650 °C in accordance with UL 746C;

b) Minimum 650 Glow wire flammability index (GWFI) in accordance with IEC 60695-2-12; or

c) Minimum 675 Glow wire ignitability temperature (GWIT) in accordance with IEC 60695-2-13.

4.3.3.4 Hoses used with ash vacuum cleaners shall be metal.

4.3.3.5 The fully extended length of the hose supplied with ash vacuum cleaners shall not exceed 2 m (78 in.).

4.3.3.6 The end of the hose handle shall have a smaller inside diameter than the body of the hose and handle to prevent hot ash from lodging in the hose or handle.

4.4 Corrosion protection

4.4.1 Iron and steel parts, other than bearings, laminations or minor parts such as washers, screws or the like, 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.

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 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 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, 5.19.8.

4.4.6 With reference to 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 CSA C22.2 No. 21 and UL 817. Flexible cords and cables shall comply with CSA 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 CSA 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 CSA C22.2 No. 42 and UL 498. Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of CSA C22.2 No. 21 and UL 817, and need not comply with CSA 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. 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 11.4.29 and 12.3.1(g), respectively.

4.5.1.6 Except as specified in 4.5.1.7, 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 4.2 or a type at least as serviceable.

Table 4.2
Cord Types

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
Docking or charging stations of automatic battery-powered floor cleaners including those with a suction function	SPT-2

[a] An oil-resistant cord shall be used 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 11.1 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) shall be used 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.

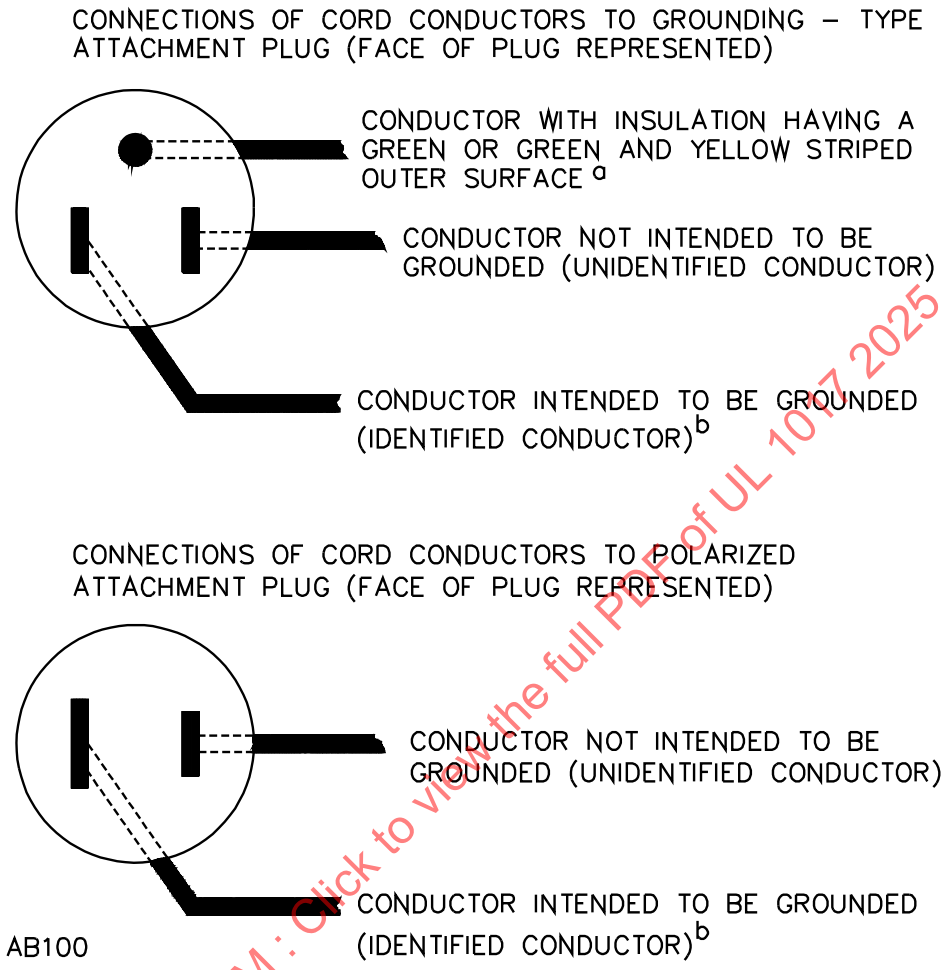
4.5.1.7 For appliances provided with a general-use receptacle or receptacles, the requirements in 4.14 are applicable; see 4.14.5 and 4.14.6 for the supply cord and cord set requirements for portable, shop-type vacuum cleaners provided with general-use receptacles.

4.5.1.8 The voltage and current rating of the attachment plug shall correspond to the voltage and current 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 11.3.2.

4.5.1.9 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 4.10.1.5, 4.13.3, and 4.14.17 shall be a polarized type. The connections to the attachment plug shall be in accordance with Figure 4.5 and Table 4.3. See also polarization instructions, 12.4.

Figure 4.5

Connections to Attachment Plug



[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 4.3.

Table 4.3
Polarity Identification of Flexible Cords

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 appliance-grounding conductor. See 4.16.5 and Figure 4.5.

[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.

4.5.1.10 An appliance that is required to employ a polarized attachment plug as specified in 4.5.1.9, and that is provided with a detachable cord set shall also employ an appliance connector of the polarized type.

4.5.1.11 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, except a utility vacuum cleaner with an angled attachment plug with an integral ALCI or GFCI device.

4.5.1.12 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.

4.5.1.13 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.

4.5.1.14 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 5.8) shall be of the special use type. See 11.4.23, 11.4.24, and 12.2.11. 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 Except as specified in 4.5.1.16, 4.5.1.18 and 4.5.1.19, for a vacuum cleaner or blower cleaner, the length of an attached flexible power supply cord or the length of a cord set (detachable power supply cord), shall not be less than 1.82 m (6 ft).

4.5.1.16 For a central vacuum cleaner and a docking or charging station including those with a suction function, the length of the flexible power supply cord or cord set shall not be less than 0.9 m (3 ft).

4.5.1.17 Except as specified in 4.5.1.19, a household-use floor finishing machine and a household extraction-type floor cleaning 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. A hand-held household extraction-type floor cleaning machine shall be provided with either a cord set (detachable power supply cord) or a power supply cord (nondetachable) not less than 3.05-m (10-ft) long.

4.5.1.18 A portable commercial appliance, portable outdoor use appliance or portable hand-supported blower cleaner may be provided with an attached power supply cord not longer than 457 mm (18 in) or with a connector base (motor-attachment plug) if:

a) The appliance is marked in accordance with 11.3.12 or provided with instructions in accordance with 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 length of an attached flexible power supply cord is measured from the face of the attachment plug cap to the point at which the cord enters the appliance. The length of a cord set (detachable power supply cord) is measured including the fittings.

4.5.1.21 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 4.5.1.12 or 4.5.1.18 shall be of the locking type. The length of the attachment cord specified in 4.5.1.18 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. However, an accessory intended for use with a central vacuum cleaning system or an accessory intended for commercial 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, 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 CSA C22.2 No. 308 and UL 355 is considered to fulfill these requirements only if it additionally complies with the applicable cord reel tests described in 5.8.3, 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 live 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 4.2 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 live pin.

4.5.2.3 A pin terminal assembly shall comply with:

a) CSA C22.2 No. 42 and UL 498; or

b) CSA No. 60320-1 and UL 60320-1; or

c) Live parts, 4.6, External interconnections, 4.7.5.8, Electrical Insulation, 4.8 and Spacings, 4.15.

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 5.14.

4.5.3.2 Except as specified in 4.5.3.3 or 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.

4.5.3.3 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 5.14.3. Thermoplastic tubing is not acceptable over thermoplastic cords.

4.5.3.4 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.

4.5.3.5 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.

4.5.3.6 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 shall comply with this end-product standard or UL 635. 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 Fixed appliances

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 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 CSA C22.2 No. 158 and UL 486E.

4.5.5.1.7 Terminal blocks shall comply with CSA C22.2 No. 158 and UL 1059, and if applicable, be suitably rated for field wiring. However, a fabricated part performing the function of a terminal block for other than field wiring, bonding or grounding need not comply with CSA C22.2 No. 158 and UL 1059 if the part complies with the requirements of 4.5.5.2 (wiring terminals and leads), 4.6 (live parts), 4.8 (electrical insulation), and 4.15 (spacings) of this end-product standard.

4.5.5.1.8 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in CSA C22.1, Wiring Methods, and NFPA 70, Wiring Methods and Materials, shall comply with this end-product standard or relevant CSA and UL component standards. Examples of relevant component standards are CSA C22.2 No. 18.1 and UL 514A, CSA C22.2 No. 18.2 and UL 514C, CSA C22.2 No. 18.3 and UL 514B, CSA 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 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 UL 83 / CSA C22.2 No. 75. The conductors shall be at least 16 AWG (1.3 mm^2), if separate, or 18 AWG (0.82 mm^2) if in a multiconductor sheath.

4.5.5.2 Wiring terminals and leads

4.5.5.2.1 A fixed 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. A wire-binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) 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, unless 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 mm^2) 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 mm^2);

b) No. 8 if for use with 14 AWG (2.1 mm^2) conductors; or

c) No. 6 if for use with conductors smaller than 14 AWG (2.1 mm^2).

4.5.5.3.2 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size indicated in 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 fixed 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 Live parts

4.6.1 A live 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 live part, unless it is provided with a corrosion-resistant coating and is acceptable in accordance with the applicable component standards specified in 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 Except for conductors for specialty applications (e.g. data processing or communications) located in an extra-low voltage circuit not involving the risk of fire or personal injury, internal wiring composed of insulated conductors shall comply with:

a) CSA C22.2 No. 127 or CSA C22.2 No. 210 and UL 758;

b) CSA C22.2 No. 38 and UL 44;

c) CSA C22.2 No. 75 and UL 83;

d) CSA C22.2 No. 49 and UL 66; or

e) The appropriate CSA and UL standard(s) for other insulated conductor types specified in CSA C22.1, Wiring Methods, and NFPA 70, Wiring Methods and Materials.

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 shall be considered to exist if, when determined as though it were film-coated wire, the wiring would comply with accessibility of live parts, 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 4.10.1.5, 4.13.3, and 4.14.17) 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 Except as specified in 4.7.3.3 and 4.7.3.4, quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG (0.34 – 5.3 mm^2) 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 CSA C22.2 No. 153 and UL 310. 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 CSA C22.2 No. 153 and UL 310.

4.7.3.3 A connector that complies with CSA 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.

4.7.3.4 For portable attended appliances with connections where the breaking of the connection would not reduce the required electrical spacings (clearance and creepage) need not comply with 4.7.3.2 if the connection complies with the following pull test and the temperature test requirements of 5.8, where the temperature of the internal wiring is recorded at the point where it is terminated at the connector [see Table 5.3, 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.

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

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

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

4.7.3.8 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.

4.7.3.9 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 4.7.3.8 or the requirements of this Standard. In such cases:

a) Insulating tape shall comply with CSA C22.2 No. 197 and UL 510;

b) Sleeving shall comply with CSA C22.2 No. 198.3 and UL 1441;

c) Tubing shall comply with CSA C22.2 No. 198.1 and UL 224.

4.7.3.10 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.

4.7.3.11 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between live 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. 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.

4.7.3.12 Wire positioning devices shall comply with 4.8 (electrical insulation). A device that complies with CSA 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 CSA 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 CSA 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 4.5.3 unless the construction is such that the cord will be protected from stress or motion. However, for 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, the force for the strain relief test, 5.14, shall be reduced to 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 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, other than those that are overmolded, shall have suitable voltage and current ratings, and be suitably rated to make and break the particular load in accordance with CSA 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.

4.7.5.8 Pin and sleeve assemblies overmolded with an elastomeric material, such as PVC, shall be suitable for the application and shall make connection with a sliding action. These assemblies shall provide adequate contact pressure and shall not deteriorate in normal use. The effectiveness of the pressure between pins and sleeve shall not depend upon the resiliency of the insulating material in which they are mounted. These assemblies shall comply with 5.32.

4.8 Electrical insulation

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

4.8.2 Except as specified in 4.8.3, 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 as specified in 5.21.10, have suitable resistance to flame as specified in 4.2.2.1, and shall have the following material properties, (a) – (d):

a) Insulating properties:

1) Volume resistivity of at least 50×10^6 Ω-cm; or

2) Compliance with the end-product leakage-current requirements (5.3) with the leakage current measurement 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 5.3.4 and 5.3.5.

b) Resistance to tracking:

1) Comparative tracking index (CTI), determined in accordance with UL 746A or IEC 60112, of at least 100 V (PLC 4 – see note (a) of Table 4.4); or

2) Proof tracking index (PTI) determined in accordance with IEC 60112 of at least 100;

c) Resistance to arcing:

1) A high current arc ignition (HAI) as specified in Table 4.4;

2) Compliance with the end-product arc resistance test, 5.25, using the power (current, voltage, and power factor) of the circuit in the end product; or

3) Having a spacing over the surface of the material of at least 12.7 mm (1/2 in) between:

i) Live parts of opposite polarity;

ii) Live parts and grounded noncurrent-carrying metal; and

iii) Live parts and exposed noncurrent-carrying metal.

d) Resistance to ignition:

1) Hot-wire ignition (HWI) as specified in Table 4.4;

2) The Abnormal overload test, 5.26;

3) The Glow-wire end-product test, 5.27; or

4) The UL 746A glow-wire ignitability test as follows:

i) The material shall have a glow-wire flammability index (GWFI) rating of at least the required glow-wire temperature specified in Table 4.5 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 4.5 of this end-product standard; and

ii) 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.

Table 4.4
Material Property

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 4.5
Glow-Wire Temperature Requirements Based Upon a Products Functional End-Use Application

Application type	Glow-wire temperature
Portable, attended, intermittent duty, household use appliance	650 °C (1202 °F)
All other portable appliance	750 °C (1382 °F)
Fixed or stationary appliance	750 °C (1382 °F)

4.8.3 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 CSA C22.2 No. 0.17 and UL 94, and is not required to be evaluated for CTI, HWI, and HAI.

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

4.8.5 Fiber shall not be used as the sole support for uninsulated live 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 5.3 and 5.4.

4.8.6 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 5.19.4.)

4.9 Motors

4.9.1 General

4.9.1.1 Motors shall be of a type suitable for the particular application. They shall be capable of carrying the normal load (see 5.2) without exceeding the permissible temperatures when the appliance is tested in accordance with the temperature test, 5.8.

4.9.1.2 Motors having a NEMA frame size shall comply with CSA 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 CSA 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) CSA C22.2 No. 100 and UL 1004-1;

b) UL 1004-1 except as specified in Table 4.6; 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, 4.4.

2) Terminal compartment, 4.5.5.

3) Internal wiring, 4.7.

4) Electrical Insulation, 4.8.

5) Motors, 4.9.

6) Capacitors, 4.12.

7) Spacings, 4.15.

8) Grounding, 4.16.

Table 4.6
Superseded Requirements

UL 1004-1 exempted requirement	Superseded by the requirements in this Standard
Current and Horsepower Relation	4.15.1.12
Cord-Connected Motors	4.5.1
Factory Wiring Terminals and Leads	4.7
Electrical Insulation	4.8
Non-Metallic Functional Parts	4.2, 4.8, and 4.9
Solid-State Controls, 7.2	4.11
Non-metallic enclosure thermal aging, 9.1.4	4.2 and 4.8
Motor enclosure – Cast Metal Enclosures, Sheet Metal Enclosures, and Polymeric Enclosures	4.2
Grounding, and Grounding Identification	4.16
Ventilation Openings: only applicable where the openings are on surfaces considered to be the appliance enclosure.	4.2.3
Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts	4.2.5

Table 4.6 Continued on Next Page

Table 4.6 Continued

UL 1004-1 exempted requirement	Superseded by the requirements in this Standard
Protection Against Corrosion	4.4
Available fault current ratings for motor start and running capacitors, Clause 26.6: not applicable for cord and plug connected appliances.	4.12
Switches is not applicable to centrifugal starting switches.	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.	11.1.1

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. 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.

4.9.1.7 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.

4.9.1.8 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall have a relative or generic thermal index for electrical properties of 105 °C (221 °F) minimum or shall be subjected to the thermal aging test of 5.24.4. 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.

4.9.1.9 Motors employing thermoplastic insulating materials shall be subjected to the tests in thermoplastic motor insulation systems, 5.24.1 – 5.24.3. However, slot liners of polyethylene terephthalate that are 0.18 mm (0.007 in) thick minimum are not required to be subjected to these tests.

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

4.9.1.11 Motors used for ash vacuum cleaners shall be of the bypass type, or a through-flow provided with an over-temperature protective device, and shall be provided with a minimum Class B (130 °C) motor insulation system and shall be of the:

a) Bypass type; or

b) Through-flow type provided with an over-temperature protective device.

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 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 as specified in 4.9.3.2 to 4.9.3.4 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 4.14.2; or

e) In a coin-operated appliance.

4.9.3.2 Thermal motor protection shall comply with the applicable requirements in CSA C22.2 No. 77 and UL 1004-3 except as follows:

a) 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.

b) 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.

c) 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.

d) For fixed appliances, the overcurrent protection of 4.9.3.10 may be used in place of thermal motor protection.

e) For other than fixed appliances, overcurrent protection, such as fuses or supplementary protectors, may be used in place of thermal motor protection if:

1) The supplementary protector/motor combination complies with the running-overload and locked-rotor protection requirements in CSA C22.2 No. 77 and UL 1004-3, as applicable; and

2) The overcurrent protection device complies with 4.17.

4.9.3.3 Impedance motor protection shall comply with the applicable requirements in CSA C22.2 No. 77 and UL 1004-2, when the motor is tested as used in the product under stalled-rotor conditions.

4.9.3.4 Electronic motor protection integral to the motor shall comply with 4.11.4, or CSA C22.2 No. 77 and UL 1004-7.

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

4.9.3.6 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 4.9.3.1.

4.9.3.7 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.

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

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

4.9.3.10 A separate device incorporated in a fixed appliance in accordance with the requirements in 4.9.3.2(d) shall be responsive to motor current and shall be rated or set in accordance with Table 4.7 (column A). Each winding connection of a multispeed motor shall be considered separately. If the rating of the device determined in accordance with Table 4.7 (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 4.7 (column B).

Table 4.7
Rating or Setting of Overload-Protective Devices

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.		

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 input

of 480 VA. The switch shall be in a readily accessible location. For a central vacuum cleaner, the motor control switch may consist of an extra-low voltage current-carrying hose contact that energizes a relay or triac which turns on the motor of the central vacuum.

4.10.1.4 A switch, relay, or similar control that controls a motor shall be subjected to the test in 5.15, unless the switch complies with the standards specified in 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 Except as specified in 4.10.1.6 and 4.10.1.7, a switch or an overcurrent-protective device of the single pole type shall be electrically connected to the ungrounded conductor of the supply circuit.

4.10.1.6 An automatic control without a marked OFF position need not be connected to the ungrounded conductor.

4.10.1.7 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.

4.10.1.8 A control shall comply with the requirements specified in 4.11.

4.10.2 Ratings

4.10.2.1 Switches that comply with CSA C22.2 No. 55 and UL 61058-1 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 CSA C22.2 No. 61058-1 and UL 61058-1 shall be rated as specified in 4.10.2.3 – 4.10.2.5.

4.10.2.3 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 7.1.2.2 of CSA C22.2 No. 61058-1 and UL 61058-1, TIL A-37 Interim Certification Requirements for Switches Used in Tools, UL 6059, or CSA No. 61058-2-6 / UL 61058-2-6 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 7.1.2.5 of CSA C22.2 No. 61058-1 and UL 61058-1, TIL A-37 Interim Certification Requirements for Switches Used in Tools, UL 6059, or CSA 61058-2-6 / UL 61058-2-6 and may be classified based upon the load conditions encountered in the appliance under normal load; see 5.2.

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

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

4.10.2.4 Ratings and load classifications for switches other than power switches shall be based on the conditions encountered in the appliance under normal load; see 5.2.

4.10.2.5 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) Interlock switches required for compliance with this Standard: 10,000 cycles for products intended for household use only and 50,000 cycles for other products.

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

e) 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 7.1.2.6 of CSA C22.2 No. 61058-1 and UL 61058-1.

4.10.2.6 Switches that do not comply with the standards specified in 4.10.2.1 or 4.10.2.2 shall be tested in accordance with 4.10.2.7 and 4.10.2.10.

4.10.2.7 Switch Endurance – three samples of the switch shall be subjected to the accelerated cycle endurance test of 17.2.4.4 of CSA C22.2 No. 61058-1 and UL 61058-1, but with the load conditions as specified in 4.10.2.8 or 4.10.2.9, and using the number of cycles as specified in 4.10.2.5.

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

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

4.10.2.9 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 17.2.3.4.1 of CSA 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 5.2;

b) The switch is opened with the appliance loaded to normal load.

4.10.2.10 Switch overload or breaking capacity – the switch shall be tested in accordance with 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 4.10.1 and 4.10.2, a vacuum cleaner with a hand-held 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 5.29 for the applicable performance requirements.

a) CSA C22.2 No. 24 and UL 60730-2-9;

b) CSA C22.2 No. 24 and UL 353; or

c) CSA-E60730-1 and UL 60730-1, and 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 5.15.3, in addition to complying with the other applicable switch requirements in 4.10.

4.10.4.2 With respect to 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 4.15.

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 unless it complies with the controls standards specified for operating controls.

4.11.3 Operating controls (regulating controls)

4.11.3.1 Operating controls shall comply with CSA E60730-1 and UL 60730-1 and any relevant Part 2 standard. However, electronic operating controls may instead be evaluated to this Standard in which case it shall be evaluated for the endurance cycles in 4.11.3.2(a) unless otherwise specified.

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

a) 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;

b) For the applicable Overvoltage Category, see Table 4.12;

c) For the applicable Material Group, see Table 4.13;

d) For the applicable Pollution Degree, see Table 4.14;

4.11.4 Protective controls (limiting controls)

4.11.4.1 Protective controls shall comply with CSA E60730-1 and UL 60730-1 and any relevant Part 2 standard including cycle requirements in 4.11.4.5 and tests in 4.11.4.2, unless otherwise specified in this Standard. However, electronic protective controls may instead be evaluated to this Standard as specified in 4.11.4.

4.11.4.2 An electronic protective 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 4.8. The general requirement is that these controls shall demonstrate functional reliability commensurate with the risk that they guard against. This can be achieved through the specific requirements of either 4.11.4.3 or 4.11.4.4 and the following environmental tests applied to the appliance contained in 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 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 5.8. The test shall be conducted for 14 days; and

g) Overload shall be conducted based on the maximum declared ambient temperature (T_{max}) or as determined by conducting the Temperature Test; see 5.8.

Table 4.8
Required Performance Levels

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 hazardous moving parts.	No	
Power switches or other controls that prevent unintended operation of motors controlling accessible hazardous moving parts, except for appliances with motor-operated brushes provided with the Warning marking of 11.4.17.	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 11.4.17.	No	–
Interlocks as required by 4.19.7.4 – 4.19.7.10 and 9.3.1.7.	Yes	b
For portable appliances, prevent overload (over temperature or overcurrent) during severe conditions and abnormal operation as required by 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 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 accessible hazardous moving parts, not provided with the Warning marking of 11.4.17.	Yes	b
Motor speed control.	No	–
Water level sensing control defeated during the test of 5.10.4 and 5.12.2.	No	–
Water level sensing control not defeated during the test of 5.10.4 and 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 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.		

4.11.4.3 The following shall be considered when judging the acceptability of safety-critical functions of an electronic control investigated using 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 electronic protective control, it shall be evaluated as software class B in Annex H, H.11.12.3 in CSA-E60730-1 and UL 60730-1.

4.11.4.4 The test parameters and conditions used in the investigation of the electronic protective control covered by 4.11.4.2 shall be as below:

a) The reliability of portions of the electronic circuit that are responsible for the safety-critical function shall be 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 G. In cases of single channel designs, the required $MTTF_d$ for each performance level shall be 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 electronic protective control, it shall be evaluated as software class B in accordance with CSA-E60730-1 and UL 60730-1, Annex H, H.11.12.3.

4.11.4.5 Unless otherwise specified in this Standard, controls with electromechanical or pressure activated actuation shall be evaluated for 10,000 cycles for products intended for household use only and 50,000 cycles for other products with the load 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) unless the capacitor is mounted in an enclosure that meets the requirements as specified in 4.2.

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 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 CSA 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 4.10 and 12.7 mm (1/2 in).

4.12.8 Electromagnetic interference filters with integral enclosures that comply with CSA C22.2 No. 8 and UL 1283 are considered to fulfill the requirements of 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 CSA C22.2 No. 43 and UL 496. 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 CSA C22.2 No. 250.13 and UL 8750, except as specified below:

a) LED light sources forming part of a luminaire that complies with an appropriate CSA and UL luminaire standard are considered to fulfill this requirement.

b) Non-user replaceable LED light sources intended for illumination or indicating purposes need not comply with CSA C22.2 No. 250.13 and UL 8750, but shall comply with the applicable requirements of this end- product standard.

4.14 Receptacles

4.14.1 Except as specified in 4.14.2, a cord-connected, portable appliance shall not be provided with a general-use receptacle.

4.14.2 Stationary and fixed appliances in addition to portable, utility vacuum cleaners may be provided with a general-use receptacle or general-use receptacles, if it complies with 4.14. In addition, these appliances shall be marked with the cautionary markings specified in 11.4.22, and be provided with the instruction specified in 12.2.12.

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

4.14.4 A cord-connected, portable, utility vacuum cleaner provided with a general-use receptacle or receptacles shall have a current rating as required in Table 4.9 and be provided with an attachment plug rated not less than the current rating of the appliance.

4.14.5 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) shall be used when the appliance is intended for outdoor use. A cord set (detachable power-supply cord) shall not be used.

4.14.6 The minimum conductor size of the power-supply cord for a portable, utility vacuum cleaner shall be as indicated in Table 4.9.

4.14.7 An overcurrent protection device (OCP) as required by Table 4.9 or 4.14.18 shall be suitably rated and comply with the following:

a) The requirements in CSA C22.2 No. 235 and UL 1077; or

b) A fuse that complies with the requirements in CSA C22.2 No. 248.14 and UL 248-14; or

c) A circuit breaker that complies with the requirements in CSA C22.2 No. 5 and UL 489.

Table 4.9
Construction and Performance Requirements for General-Use Receptacles Provided on Portable, Cord-Connected Utility Vacuums

Number of receptacles	Minimum supply cord size AWG (mm^2)	Appliance current rating, minimum A	Supplementary OCP required?	Supplementary OCP rating, if provided A	Minimum internal wiring size[a] AWG (mm^2)	Total receptacle load[b] A
6	12 (3.3)	20	Yes	20	12 (3.3)	20
5	12 (3.3)	20	No	20	12 (3.3)	20
4	14 (2.1)	15	Yes	15	14 (2.1)	15
1 – 3	14 (2.1)	15	No	15	14 (2.1)	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 5.2.7.1.

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

4.14.9 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.

4.14.10 The receptacles of an appliance shall comply with the applicable requirements in CSA 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 CSA C22.2 No. 42 and UL 498.

4.14.11 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.

4.14.12 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 CSA C22.2 No. 144.1 and UL 943.

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

4.14.14 Polymeric material that encloses unswitched receptacles associated circuitry that is always energized when the appliance is plugged in shall comply with 4.2.1.8(b).

4.14.15 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 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).

4.14.16 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 11.4.22(b).

4.14.17 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. The grounded supply conductor shall be identified with a continuous white or grey covering or by three continuous white stripes along the entire length of the conductor.

4.14.18 If a fixed 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 specified in 4.15.1.7, 4.15.1.9, and 4.15.3, spacings shall not be less than those specified in Table 4.10 or Table 4.11. 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.

Table 4.10
Minimum Spacings for Uninsulated Live Parts at Supply Wiring Terminals

Potential involved	Over surface		Through air	
V	mm	(in)	mm	(in)
250 or less	6.4	(1/4)	6.4	(1/4)
NOTES: 1 For extra-low voltage circuits, see 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 4.11.				

Table 4.11
Minimum Spacings at Other than Supply Wiring Terminals

Potential involved		Motor diameter 178 mm (7 in) or less[b]			
		Over surface		Through air	
V	Rating of motor employed[a]	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 4.15.1.9.					

[a] See 4.15.1.12 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.

4.15.1.2 Spacings at wiring terminals to which supply connections are made in the field shall comply with Table 4.10:

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 shall not be less than those specified in Table 4.10 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 Except as specified in 4.15.1.5 and 4.15.1.6, spacings shall comply with Table 4.11 at points other than as specified in 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.

4.15.1.5 In other than safety or protective control circuits, a spacing less than the minimum specified in Table 4.11 is acceptable under the conditions described in the low power circuit as specified in CSA 60730-1 or UL 60730-1.

4.15.1.6 Spacings between traces on a printed wiring board need not comply with Table 4.11 if the printed wiring board complies with the printed wiring board abnormal operation test in 5.10.6. The requirements specified in 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 4.11.

4.15.1.7 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 4.1. However, the spacings within a motor complying with Table 4.11 need not comply with the component spacings requirements in CSA C22.2 No. 100.

4.15.1.8 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 4.2.4; 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.

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

a) An extra-low voltage circuit – see 3.19;

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 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.

4.15.1.10 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 4.15.1 and shall be judged on the basis of the highest voltage involved.

4.15.1.11 In applying Table 4.11 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.

4.15.1.12 In applying Table 4.11 to a motor not rated in horsepower, use shall be made of the appropriate table of the Electrical Code (see 1.1) 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 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 specified in 4.15.2.3.

4.15.2.2 The spacing mentioned in 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 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 specified in Table 4.4. 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 4.8.2.

4.15.3 Alternate spacings – Clearances and creepage distances

4.15.3.1 As an alternative to the spacing requirements of Table 4.11, the spacing requirements in CSA C22.2 No. 0.2 and UL 840 may be used. The spacing requirements of CSA 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 4.12;

b) For the applicable Material Group, see Table 4.13;

c) For the applicable Pollution Degrees, see Table 4.14.

Table 4.12
Overvoltage Categories

Circuit	Overvoltage Category
Fixed appliances	III
Line-voltage	II
Extra low-voltage	I

Table 4.13
Material Group

CTI PLC value of insulating materials	Material group
CTI ≥ 600 (PLC = 0)	I
400 ≤ CTI < 600 (PLC = 1)	II
175 ≤ CTI < 400 (PLC = 2 or 3)	IIIa
100 ≤ 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 4.14
Pollution Degrees

Clearances and creepage distances microenvironment	Pollution degree
No pollution or only dry, nonconductive pollution. The pollution has no influence. 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.	1
Normally, only nonconductive pollution. However, a temporary conductivity caused by condensation may be expected. 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. Appliances that use totally enclosed motors without brushes or internal lubrication systems. Appliances that use open motors for use in equipment for ordinary locations and indoor use, such as: a) Residential appliances; and b) Commercial appliances for use in a clean environment.	2
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

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 CSA 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 CSA 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 or, for cord-connected appliances without general use receptacles, be provided with a system of double insulation as specified in Section 6:

a) An appliance intended to be used on a circuit operating at more than 150 V to ground (see 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) Appliances with general-use receptacles;

h) An electrified wall valve assembly (see 8.2.7); or

i) An appliance intended to be used outdoors.

4.16.2 With reference to 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 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 4.16.4 and if the appliance is cord connected it shall comply with the requirements in 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 bonding/equipment grounding. Connections shall meet the requirements for the ground impedance test in CSA C22.2 No. 0.4. 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 a fixed appliance intended to be connected by a metal-enclosed wiring system – a knockout or equivalent opening in the metal enclosure of the appliance;

b) In a fixed appliance intended to be connected by a nonmetal-enclosed wiring system, for example, nonmetallic sheathed cable – an equipment-grounding terminal or lead, see 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 live 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 except for interlocked plugs, receptacles and connectors that are not energized when the equipment grounding connection is made, shall be such that the equipment-grounding connection is made before connection to and broken after disconnection from the supply circuit.

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 11.1.

4.16.10 Fixed 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 specified in 4.17.4.

4.17.3 A protective device shall be wholly inaccessible from outside the appliance without opening a door or cover, except for the means for manually resetting a protective device, such as the operating handle of a circuit breaker or the reset button of a manually operable motor protector.

4.17.4 The protective device mentioned in 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 CSA C22.2 No. 248.1 and UL 248-1, and the applicable Part 2 (e.g., CSA C22.2 No. 248.5 and UL 248-5). Defined use fuses that comply with CSA 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.

4.17.6 Electronic circuits providing thermal or overcurrent protection relied upon for compliance with this Standard shall be evaluated in accordance with 4.11.4.

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

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

4.17.9 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with CSA C22.2 No. 144.1 and UL 943.

4.17.10 Appliance-leakage-current interrupters (ALCI) shall comply with UL 943B or CSA C22.2 No. 270, if provided.

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

4.17.12 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.

4.17.13 Arc-fault circuit-interrupters (AFCI) shall comply with UL 1699 or CSA C22.2 No. 270.

4.17.14 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with UL 1699 or CSA C22.2 No. 270.

4.17.15 Arc fault detection testing shall include the applicable UL 1699 or CSA C22.2 No. 270 tests required for cord-type arc-fault circuit-interrupters. The carbonized path arc clearing time test is not applicable for LCDIs that are provided with shielded power-supply cords.

4.17.16 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.

4.17.17 A thermal link, required for compliance with this Standard, shall comply with the applicable requirements of CSA E60691 and UL 60691.

4.17.18 The thermal link, required for compliance with this Standard, 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 5.1.2 and operated in a normal position to cause abnormal heating.

4.17.19 To determine compliance with 4.17.18, the appliance shall be operated five times as described in 4.17.18 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 shall perform acceptably. During the test, the enclosure shall be connected through a 3-A fuse to a supply conductor not containing the thermal link.

4.18 Heating elements / steam generators

4.18.1 A heating element used for a steam-cleaning function shall comply with the applicable requirements of CSA 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 Protection against injury to persons

4.19.1 General

4.19.1.1 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. When judging an appliance with respect to the requirement in this Clause, consideration shall be given to reasonably foreseeable misuse of the appliance.

4.19.1.2 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.

4.19.1.3 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.

4.19.1.4 Interlocking functions achieved with electronic controls, the malfunction of which could result in injury to persons, shall be evaluated by 4.11.4.

4.19.2 Sharp edges

4.19.2.1 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 unless the part is needed to perform a working function, such as the metal-toothed blade of a pet grooming attachment or a moving part.

4.19.2.2 Whenever referee measurements are necessary to determine that a part as mentioned in 4.19.2.1 is not sufficiently sharp to constitute a risk of injury to persons, the method described in UL 1439 shall be used.

4.19.3 Enclosures and guards

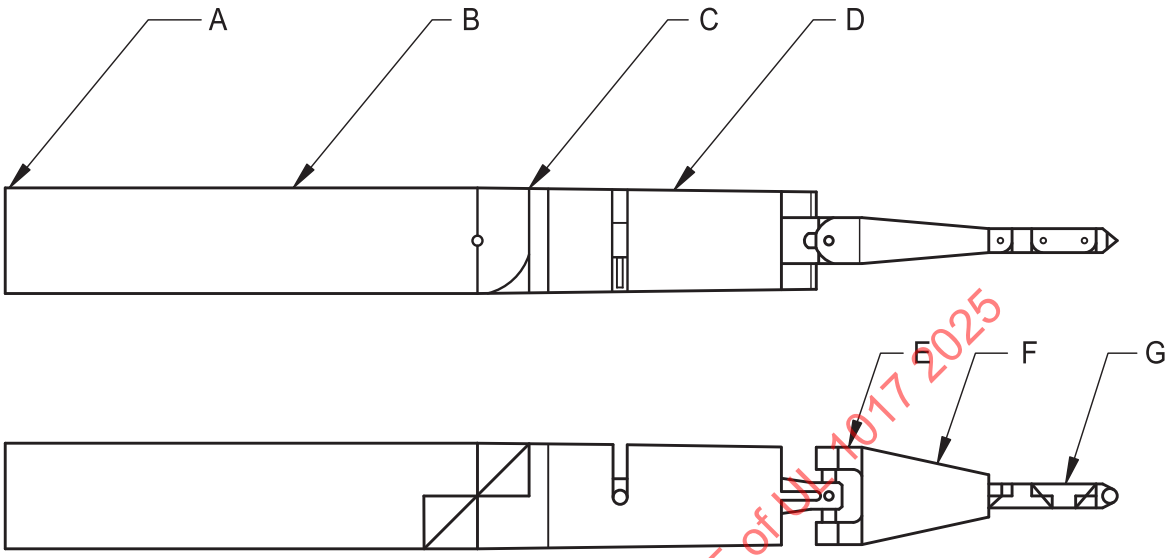
4.19.3.1 Except as indicated in 4.19.3.2 and 4.19.3.3, the rotor of a motor, a pulley, a belt, a gear, a fan, or other moving part that could cause injury to persons shall be enclosed or provided with other means to reduce the likelihood of unintentional contact. An opening in an enclosure or guard shall comply with either (a) or (b).

a) For an opening that has a minor dimension less than 34.9 mm (1.375 in), a hazardous moving part shall not be contacted by the probe illustrated in Figure 4.2. See 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, a hazardous moving part shall not be contacted by the probe illustrated in Figure 4.6 and Figure 4.7. See 4.2.5.5 and Annex A.

Figure 4.6

Accessibility Probe for Openings 1.375 in (34.9 mm) or More



su0252

A – Upper arm circumference – female – 5th percentile = 11.9 cm (4.685 in)

B – Shoulder to elbow length – male – 95th percentile = 16.8 cm (6.61 in)

C – Forearm circumference – female – 5th percentile = 12.1 cm (4.76 in)

D – Lower arm length – male – 95th percentile = 22.7 cm (8.94 in) (elbow to fingertip)

E – Minimum hand clearance diameter – female – 5th percentile = 3.49 cm (1.374 in)

F – Hand length – male – 95th percentile = 10.2 cm (4.016 in)

G1 – Middle finger length – male – 95th percentile = 4.5 cm (1.772 in)

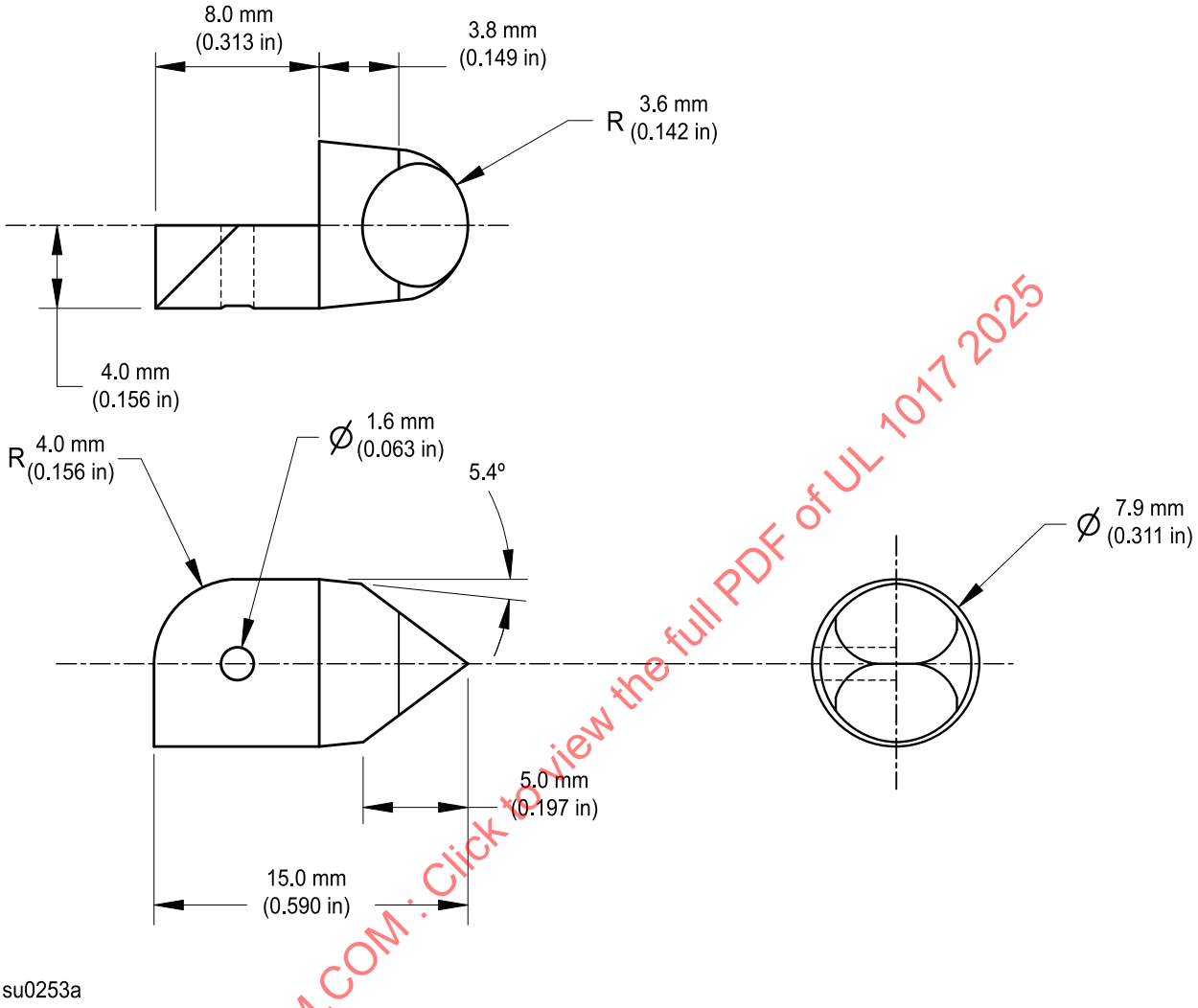
G2 – Middle finger diameter – female – 5th percentile = 0.79 cm (0.311 in)

All dimensions apply to the 13 – 18 month age bracket (male and female).

See http://ovrt.nist.gov/projects/anthrokids/child.html for more details.

Figure 4.7

Finger Tip Detail



su0253a

4.19.3.2 A portion of a moving part that is necessarily exposed to perform the work function need not be enclosed. The degree of exposure necessary to perform the intended function shall be considered.

4.19.3.3 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 4.4 and 4.19.3.1 does not apply.

4.19.3.4 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 unless it is marked in accordance with 11.4.16.

4.19.3.5 During the examination of a central vacuum cleaner or a dust extractor to determine whether the appliance complies with the requirements in 4.19.3.1, all the attachments and fittings recommended in the installation manual shall be installed as intended. For a central vacuum with a marking in accordance with 11.3.10, or instructions in accordance with 12.5.6, the exhaust piping shall also be in place during this examination.

4.19.3.6 With respect to intended operation of the appliance, user maintenance, and reasonably foreseeable misuse, a hazardous moving part shall be considered with respect to:

a) The sharpness of the moving part;

b) The speed of the moving part;

c) The torque or force of the moving part; and

d) The capability to endanger a part of the body or entangle clothing.

4.19.3.7 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.

4.19.3.8 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 11.4.30 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 5.19.3;

b) Mold stress-relief distortion test in accordance with 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.

4.19.4 Surface temperatures

4.19.4.1 During the temperature test, 5.8, the temperature of a surface that can be contacted by the user shall not be more than the value specified in Table 4.15. If the test is conducted at a room temperature of other than 25 °C (77 °F), the results shall be corrected to that temperature.

4.19.4.2 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 4.15 when measured in

accordance with the applicable requirements in the Temperature Test, 5.8, unless the surface is not a handle or knob and is marked in accordance with 11.4.26.

Table 4.15
Maximum Surface Temperatures

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.

4.19.5 Stability

4.19.5.1 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, 5.13, and shall not overturn. An upright-type appliance that is hand guided while in use is not required to be tested. However, 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.

4.19.6 Strength of handles

4.19.6.1 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 appliance to which the handle is attached. See strength of handles, 5.20.

4.19.6.2 The strength of handles test is not applied to handles that are intended for use in removing a part for cleaning or servicing only and not intended for carrying the appliance.

4.19.7 Interlocks, switches, and controls

4.19.7.1 An appliance shall be constructed so as to reduce the likelihood of unexpected operation of any accessible hazardous moving parts. Each function of a multiple-function appliance shall be taken into consideration.

4.19.7.2 If unintentional operation of a switch can result in operation of an accessible hazardous moving part, the actuator of the switch shall be located or guarded by recessing, ribs, barriers or the like so that such operation is unlikely. A power switch controlling the operation of an accessible hazardous moving part shall be considered to be located or guarded so that unintentional operation is unlikely if the switch is not actuated when the appliance is placed on both flat carpeted and non carpeted 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 5.2.1.2.

4.19.7.3 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.

4.19.7.4 The requirement in 4.19.7.3 necessitates the use of an interlock if automatic starting of the appliance would result in operation of accessible hazardous moving parts.

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

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

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

4.19.7.8 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.

4.19.7.9 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 4.19.7.5.

4.19.7.10 For an interlock required for compliance with this Standard, electromechanical interlock controls shall comply with 4.10, and electronic interlocks shall comply with 4.11.4.

4.19.8 Blower cleaner impellers

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

4.19.8.2 The blower cleaner shall be tested as described in blower cleaner impeller tests, 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.

4.19.8.3 The visual inspection described in 4.19.8.2 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.

4.19.9 Parts subject to pressure – Vacuum with steam-cleaning attachments

4.19.9.1 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.

4.19.9.2 To determine compliance with 4.19.9.1, 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 specified in 4.19.9.3.

4.19.9.3 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.

4.19.9.4 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.

4.19.9.5 The start-to-discharge pressure setting of the pressure-relief device of 4.19.9.4 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.

4.19.9.6 The pressure-relief device of 4.19.9.4 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.

4.19.9.7 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.

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

4.19.9.9 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.

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 5.1 and maintained at that voltage throughout the test.

Table 5.1
Test Voltages

Appliance marked rating V	Test voltage V
110 – 120	120
200 – 208	208
220 – 240	240

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 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 F655. 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 F655. 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. 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. Other than docking stations with a vacuum function, for products with a timer, such as a coin-operated machine, the appliance shall be operated using a duty cycle with a time of operation equivalent to the maximum operating time allowed by the timer followed by a 2-minute off time until constant temperatures are attained. Docking stations with a vacuum function are operated for three cycles with a 2-minute off time between cycles.

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. A mechanical air-flow valve that is not adjustable, or similar device that complies with the mechanical valve endurance test in 5.30 shall be allowed to operate during the Rating and Temperature tests.

5.2.2 Portable vacuum cleaners

5.2.2.1 The vacuum cleaner shall be operated with the vacuum cleaner air intake closed off sufficiently to maintain a mean wattage input to the appliance as specified in 5.2.2.3.

5.2.2.2 For upright type vacuum cleaners with an integral port for connection of above floor cleaning tools, the hose shall be connected to this attachment port, whether the hose is permanently connected or detachable, and the air intake at the end of the hose shall be used for this test condition. For other vacuum cleaners, if the hose is permanently connected or the appliance cannot be operated without a hose connected to the air intake, the hose shall be connected, and the air intake at the end of the hose shall be used for this test condition. However, if agreeable to those concerned, a non-detachable hose may be removed for this test, and a detachable hose shall remain attached if recirculation could occur.

5.2.2.3 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, unless it complies with the mechanical valve endurance test of 5.30.

5.2.2.4 If it is not possible to measure sealed suction due to the technology employed in the vacuum cleaner, the alternative method using mean air flow described in 5.2.2.5 may be used. Examples of such vacuum cleaners include those using electronics to provide continuous steady power, vacuum cleaners employing automatic (not user controlled) performance booster functions, and vacuum cleaners designed to shut off within 15 – 20 seconds of the air intake becoming sealed.

5.2.2.5 Using a suitable air flow measuring instrument, measure and record the airflow (CFM) with the vacuum cleaner air intake completely open. Airflow is considered to be zero with the air intake completely sealed. The Mean Air Flow point is 50 % of the air flow measured with the vacuum cleaner air intake completely open. While monitoring the air flow, the vacuum cleaner air intake is then reduced until the average air flow point is reached, as measured with the air flow meter as close to the air intake as possible.

5.2.2.6 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 5.2.4.

5.2.2.7 A vacuum cleaner employing a motor-driven brush (or similar device) shall be additionally operated on the test carpet described in 5.2.1.2. However, a vacuum cleaner employing a motor-driven brush (or similar device) intended for use on a hardsurface shall be tested on a previously polished composition-tile floor. 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.

5.2.2.8 A vacuum cleaner that has provision to be operated as a blower shall be additionally operated as specified in 5.2.5.

5.2.2.9 A dust extractor shall be operated with the air intake completely opened. When the product employs a flow-through type motor, where ventilating air is dependent on the working air flow, the product shall be additionally tested in accordance with 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 11.3.8, as applicable. Other than as specified in 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 5.2.2.3.

5.2.3.2 If a central vacuum cleaner is marked in accordance with 11.3.10, provided with instructions in accordance with 12.5.6 or provided with a means for connecting an outdoor exhaust and is marked in accordance with 11.3.9, the exhaust piping shall be in place during the test described in 5.2.3.1.

5.2.4 Motorized nozzles

5.2.4.1 A motorized nozzle shall be operated continuously with a vacuum cleaner attached until constant temperatures are reached. While operating, the nozzle shall be moved forward and backward, simulating normal use over a carpet as described in 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 750 W.

5.2.4.3 A motorized nozzle intended for use on a hard surface only shall be tested on a previously polished composition-tile floor.

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 Floor finishing machines

5.2.6.1 Household type

5.2.6.1.1 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.

5.2.6.2 Household extraction type

5.2.6.2.1 Household extraction type carpet cleaners are tested while being moved simulating normal use on carpet as described in 5.2.1.2. However, those intended for use on hard floors only, are tested on the hard floor as specified in 5.2.4.3.

5.2.7 General-use receptacles

5.2.7.1 For an appliance provided with general-use receptacle(s) in which the appliance and the receptacles cannot be energized at the same time, the appliance shall be additionally operated with the receptacles connected to a resistive load equal to the applicable total receptacle load value given in Table 4.9; see note b of Table 4.9.

5.2.7.2 Where the appliance and receptacles can be energized at the same time, the appliance shall be operated with the receptacle(s) loaded with the intended ampere load; see 11.1.9.

5.2.8 Vacuums with steam-cleaning attachments

5.2.8.1 For a vacuum with a steam-cleaning attachment, the normal load for the vacuum mode shall be in accordance with 5.2.1 and 5.2.2, and the normal load for the steam-cleaning mode shall be in accordance with 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 5.2.8.3. The voltage to the motor operated part of the appliance shall be in accordance with 5.1.2. The appliance shall be operated continuously, unless the appliance has a water reservoir that needs to 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 5.1.2 shall be adjusted to compensate for appliances that, when tested as specified in 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 Vm 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 5.29 and Table 5.2, 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.

Table 5.2
Number of Cycles of Operation for Endurance Test

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 5.3 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	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 5.10.4 during continuous abnormal operation of the appliance.

Table 5.2 Continued on Next Page

Table 5.2 Continued

Type of thermostat	Automatically reset thermostat	Manually reset thermostat
	evidence of risk of fire as described in 5.10.4 during the 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 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.		

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 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 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 5.2.9.2 and 5.2.9.3.

5.3 Leakage current

5.3.1 Except as specified in 5.3.2, the leakage current of a single-phase cord-connected appliance when tested in accordance with 5.3.4 – 5.3.9 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 6.12 for an appliance marked to indicate that it employs double insulation.

5.3.2 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 the limits specified in 5.3.1, but shall not exceed 2.5 MIU during a period of 5 minutes beginning with the moment the leakage current exceeds the specified limits. At the end of the 5 minute period, the leakage current shall not be more than the limits specified in 5.3.1.

5.3.3 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.

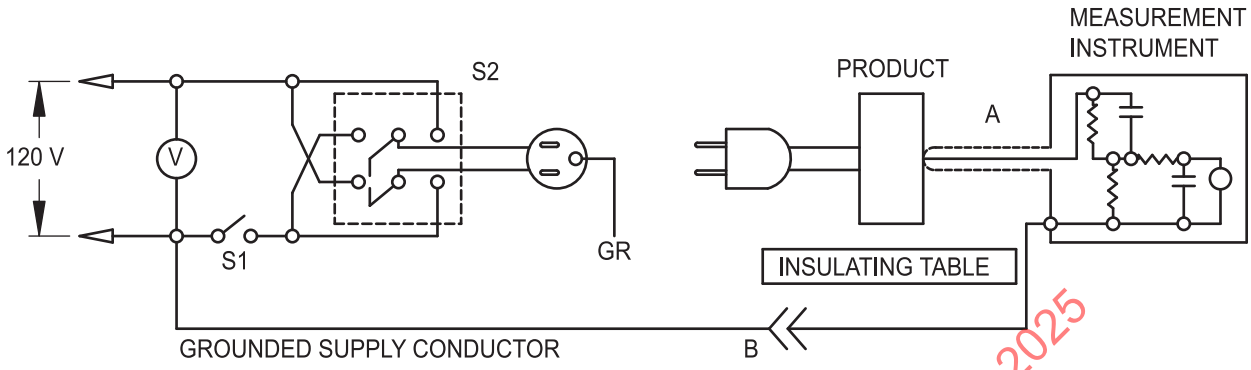
5.3.4 All exposed conductive surfaces shall be tested for leakage currents. The leakage currents from these surfaces shall be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. 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.

5.3.5 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.

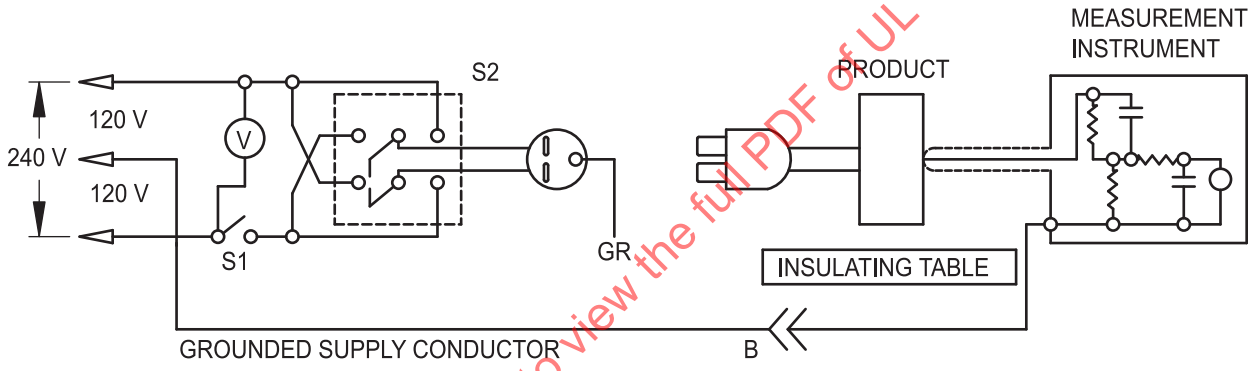
5.3.6 The measurement instrument shall be as described in UL 101, and if applicable, shall be set to reaction mode. The measurement circuit shall be as illustrated in Figure 5.1.

Figure 5.1

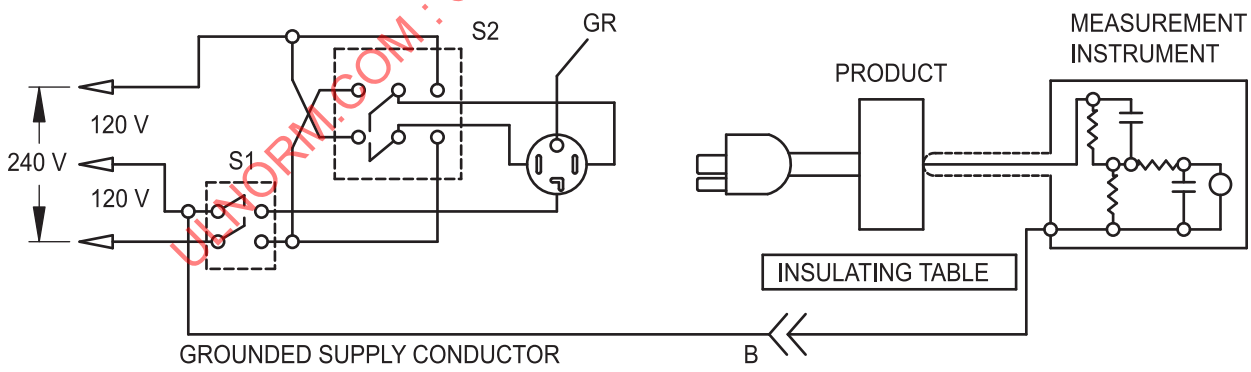
Leakage Current Measurement Circuits



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.

5.3.7 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 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.

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

5.3.9 For an appliance employing discharge-path resistors or ground connected radio-interference capacitors except Y1 capacitors complying with UL 60384-14 and CSA E60384-14 as described in 4.2.5.7 the resistors or capacitors 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, 5.3, following conditioning for 48 h in moist air having a relative humidity of 88 ±2 % at a room temperature of 32.0 ±2.0 °C (89.6 ±3.6 °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 or ground connected radio-interference capacitors except Y1 or capacitors complying with UL 60384-14 and CSA E60384-14 as described in 4.2.5.7, the resistors or capacitors 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 5.5.2 – 5.5.5, 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 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 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 5.3.4 – 5.3.8.

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 or ground connected radio-interference capacitors except Y1 capacitors complying with UL 60384-14 and CSA E60384-14 as described in 4.2.5.7, the resistors or capacitors 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. However, a time-delay fuse may be used, as specified in 5.6.3. During the test in 5.6.2, the fuse shall not open or an overload protector provided as part of the appliance shall not trip.

5.6.2 To determine whether an appliance complies with the requirement in 5.6.1, the appliance shall be started three times under conditions of normal load as described in 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 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 11.3.5.

5.7 Rating

5.7.1 Except as specified by 5.7.2 or 5.7.4, 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 5.2.

5.7.2 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 attachment normal load conditions, as described in 5.2.8.

5.7.3 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 5.2.

5.7.4 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 (See 7.2) shall be tested under the applicable conditions of normal load as described in 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 5.3. A

protective device, such as a thermal or overload protective device, shall not cause the appliance to cease normal operation during the test.

5.8.2 All values for temperature rises in Table 5.3 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).

Table 5.3
Maximum Acceptable Temperature Rises

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 fixed appliance in which power-supply conductors are to be connected, including such conductors themselves, unless the appliance is marked in accordance with 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 specified 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)

Table 5.3 Continued on Next Page

Table 5.3 Continued

Materials and component parts	°C	(°F)
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)
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. Class H (180 °C) insulation on coil windings of a-c motors having a frame diameter of more than 7 in (178 mm), of a d-c motor, and a universal motor[a]		
a) In open motors		
Thermocouple method	125	(225)
Resistance method	135	(243)

Table 5.3 Continued on Next Page

Table 5.3 Continued

Materials and component parts	°C	(°F)
b) In totally enclosed motors		
Thermocouple method	130	(234)
Resistance method	140	
23. Class H (180 °C) insulation on coil windings of a-c motors having a frame diameter of 7 in (178 mm) or less – not including a universal motor – and on a vibrator coil[a]		
a) In open motors		
Thermocouple or resistance method	135	(243)
b) In totally enclosed motors		
Thermocouple or resistance method	140	(252)
24. Switches, relays, controls, thermostats, temperature limiters, supplementary protectors, and similar components[f]		
a) For switches approved to UL 61058-1 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)
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)

Provided that the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table. See 5.8.5.

[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.

[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.

[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).

[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.

[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.

5.8.3 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.

5.8.4 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.

5.8.5 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.

5.8.6 Thermocouples shall consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) 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 ASTM E230/E230M.

5.8.7 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 shall 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 5.2, while connected to the extreme operating voltages (high and low) specified in Table 5.4. The normal load shall be established at the test voltage specified in Table 5.1, 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 5.3 plus an additional 20 °C (36 °F) rise.

Table 5.4
Extreme Operating Voltages

Appliance rating, V	Test voltages, V	
	Low	High
110 – 120	104	127
200 – 208	187	220
220 – 240	208	254

5.9.2 Central vacuum cleaners – Blocked and open inlet

5.9.2.1 A central vacuum cleaner shall be operated as described in 5.9.2.2. The temperature of the windings of a Class A (105) insulated motor shall not exceed:

a) 140 °C (284 °F) for Class A (105) insulated motors;

b) 165 °C (329 °F) for Class B (130) insulated motors;

c) 190 °C (374 °F) for Class F (155) insulated motors; or

d) 215 °C (419 °F) for Class H (180) insulated motors.

5.9.2.2 To determine whether a central vacuum cleaner complies with the requirement in 5.9.2.1, it shall be installed and operated as described in 5.2.3, 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 5.10.2 – 5.10.8.

5.10.1.2 Operation under the abnormal conditions specified in 5.10.2 – 5.10.8 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, 4.2.5; or

d) Following the applicable abnormal condition(s), the appliance does not comply with the electric strength test, 5.11.

5.10.1.3 For the abnormal operation tests specified in 5.10.2 – 5.10.8, 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. 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 electric strength test specified in 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 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 specified in 5.2.8.5, until ultimate results. If provided, low water sensing circuits not evaluated for reliability shall also be defeated. 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 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 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 5.10.1.2, after having been subjected to the abnormal test in 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 is exceeds 5 MIU. The liquid container shall be filled with the hard-water solution described in 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 4.15.1.6, a printed wiring board shall be tested as described in 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 5.1. A foil trace shall be short-circuited to each of its adjacent traces that do not have the spacing specified in Table 4.11 one at a time.

5.10.6.4 The test shall be continued for 1 h or until one of the conditions described in 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 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.

5.10.8 Ash vacuum cleaners

5.10.8.1 The ash vacuum cleaner is prepared for operation according to the instruction for use, but switched off.

5.10.8.2 The empty container of the ash vacuum cleaner is filled up to 2/3 of its useable volume with paper balls. The paper balls are made out of crumpled sheets of A4 copy paper having a weight of 70 – 120 g/m^2 in accordance with ISO 216. Each paper shall be crumpled to a size that it fits into a cube having sides of 10 cm.

5.10.8.3 The paper balls are ignited with a burning paper strip positioned in the center of the paper balls top layer. After 1 min the container is closed and kept in this position until steady conditions are reached.

5.10.8.4 The test is repeated with a new sample but with all suction motors switched on immediately after the closing of the container. If the ash vacuum cleaner has a control for air flow adjustment, the test shall be done with minimum and maximum air flow settings.

5.11 Electric strength 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 specified in 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 specified 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 electric strength test, 6.13, for an appliance marked to indicate that it employs double insulation.

5.11.2 For applying 5.11.1 to motors not rated in horsepower, reference shall be made to 4.15.1.12.

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 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 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 or ground connected radio-interference capacitors except Y1 capacitors complying with UL 60384-14 and CSA E60384-14 as described in 4.2.5.7, or radio interference capacitors connected to ground, or connected between primary and accessible secondary circuits, the connection shall be open-circuited at the point of attachment to the accessible part or at the ground connection.

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 11.1 shall be tested as described in 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:

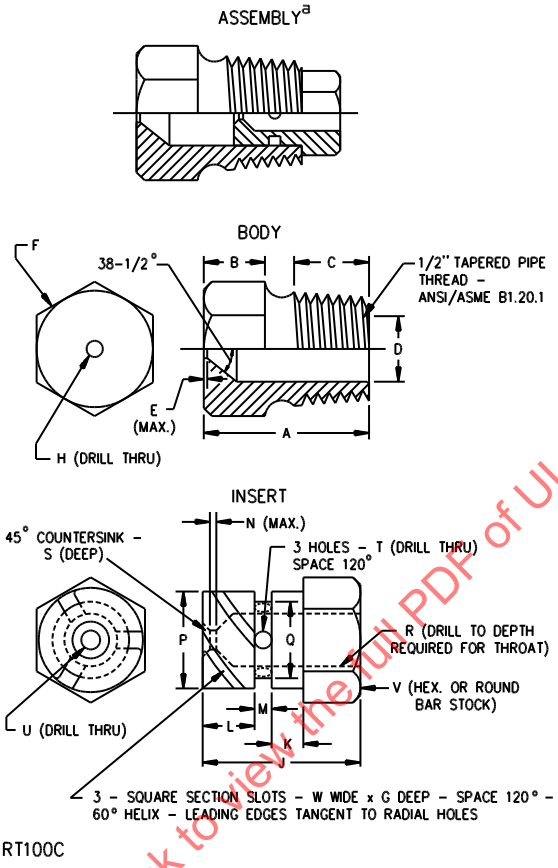
1) A cord-connected appliance shall comply with the requirements in 5.3, leakage current test, except that the test shall be discontinued when the leakage current stabilizes; and

2) An appliance shall comply with the electric strength test in 5.11.

5.12.1.2 To determine whether a vacuum cleaner complies with the requirements in 4.2.3.5 and 5.12.1.1, the appliance shall be mounted under the apparatus described in 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 5.2 and mounted in a water supply pipe rack as illustrated in Figure 5.3. The water pressure shall be maintained at each spray head at approximately 34 kPa (5 lbf/in^2). 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.

Figure 5.2
Spray Head



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)		14.63	(0.576)
D	14.68	(0.578)	Q	11.51	(0.453)
	14.73	(0.580)		11.53	(0.454)
E	0.40	(1/64)	R	6.35	(1/4)
F	c	c	S	0.80	(1/32)
G	1.52	(0.06)	T	2.80	(No. 35)[b]
H	5.0	(No. 9)[b]	U	2.50	(No. 40)[b]
J	18.3	(23/32)	V	16.0	(5/8)
K	3.97	(5/32)	W	1.52	(0.06)
L	6.35	(1/4)			
M	2.38	(3/32)			

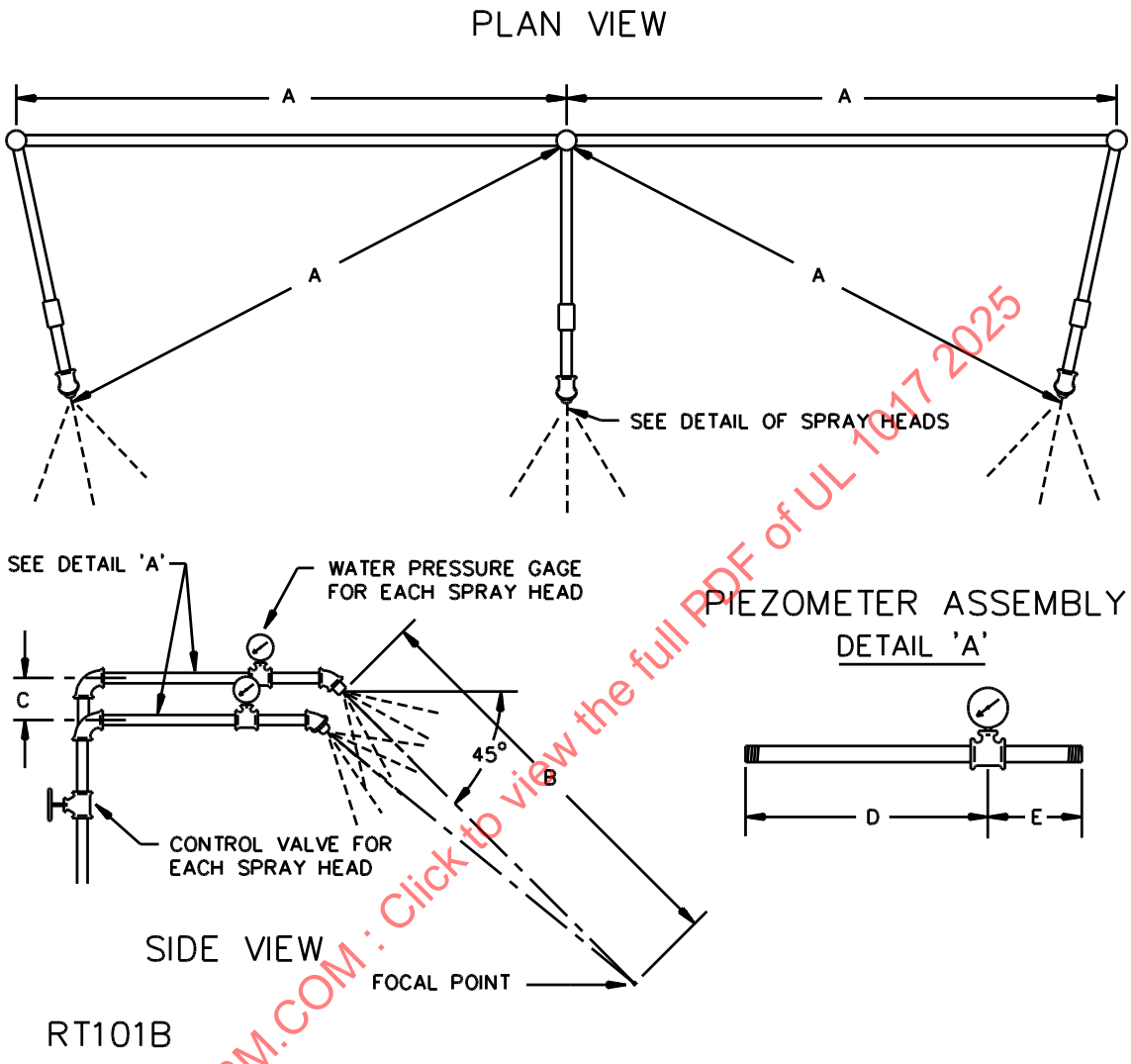
[a] Nylon Rain-Test Spray heads are available from Underwriters Laboratories Inc.

[b] ANSI B94.11M Drill size

[c] Optional – To serve as wrench grip.

Figure 5.3

Spray Head Pipe Rack



Item	mm	(in)
A	710	(28)
B	1400	(55)
C	55	(2-1/4)
D	230	(9)
E	75	(3)

5.12.2 Wet pick-up

5.12.2.1 A wet pick-up appliance shall be conditioned as described in 5.12.2.3 and 5.12.2.5. After the conditioning:

a) There shall be no obvious wetting of any uninsulated live part (see 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 electric strength test specified in 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 5.3;

2) If double insulated, shall comply with the leakage current and electric strength test specified in 6.12.1 and 6.19.

5.12.2.2 Obvious wetting 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 specified 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 specified 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 specified in (a) and that is not provided with a float shall be operated for 5 min after it begins to discharge water.

5.12.2.4 During the tests of 5.12.2.3, the temperatures of the motor winding shall not exceed:

a) 140 °C (284 °F) for Class A insulated motors;

b) 165 °C (329 °F) for Class B insulated motors;

c) 190 °C (374 °F) for Class F insulated motors; or

d) 215 °C (419 °F) for Class H insulated motors.

5.12.2.5 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 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.

5.12.2.6 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 5.12.2.7 or 5.12.2.8, respectively:

a) There shall not be obvious wetting of any uninsulated live part or film-coated wiring (see 5.12.2.2); and

b) The appliance:

1) Shall not have a leakage current of more than 0.5 MIU when tested as described in 5.3 during and immediately after operation; and

2) Shall comply with the electric strength test specified in 5.11 after operation.

5.12.2.7 A motorized nozzle of the type specified in 5.12.2.6 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.

5.12.2.8 An appliance of the type specified in 5.12.2.6 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 specified 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 5.12.3.2. The appliance shall comply with 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 electric strength 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 5.12.4.2, unless the reservoir must be removed from the appliance to be filled. During and after conditioning, the appliance shall comply with 5.12.2.1. The test shall be conducted with the control switch in the on position and switch S1 from Figure 5.1 open.

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 9.5 mm (3/8 in) 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 or obvious wetting of any uninsulated live part or film-coated wiring (see 5.12.2.2); of an appliance that employs water or other electrically conductive liquid in its operation. The appliance shall comply with 5.12.2.1.

5.12.5.2 To determine whether an appliance complies with the requirement in 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. However, 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 2.2, is not required to be removed if the part complies with 5.12.5.4.

5.12.5.3 With reference to 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 5.12.5.2 for parts for use with water or a proprietary fluid, three samples of a part, such as a boot, diaphragm, seal, or gasket, shall be subjected to each applicable condition as described in Table 5.5. 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. However, 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.

Table 5.5
Artificial-Aging Tests

Temperature on component during normal temperature test	Artificial-aging procedure
60 °C (140 °F) or less[a]	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)[a]	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)

[a] If the part is subjected to water only in its operation, the part need not comply with the immersion conditioning.

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 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 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, 5.3; and

c) The appliance shall comply with the electric strength test, as specified in 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 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 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, 5.3; and

c) The appliance shall comply with the electric strength test, 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 5.12.6.5. As a result of the tests:

a) There shall not be obvious wetting of any uninsulated live parts (See 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, 5.3; and

c) The appliance shall comply with the electric strength test, 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 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 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 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 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 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 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 electric strength test, 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 5.3; and

If double insulated, shall comply with the leakage current test, 6.12, and electric strength test, 6.19.1(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 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. (See 5.12.2.2);

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 5.3, 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 electric strength test specified in 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 6.19 (applying 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 electric strength test specified in 6.19.

5.12.8.1.2 Except as specified in 5.12.8.1.3 and 5.12.8.1.4, to determine if an appliance using a PFHC complies with 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. For tubing with an inside diameter of 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. The hole shall then be plugged and the reservoir shall be filled to 50 ±5 % of its capacity with the solution described in 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.

5.12.8.1.3 For a household extraction-type floor cleaning machine, a PFHC intended for use only with water, and complying with 5.12.8.2 is not subjected to the test of 5.12.8.1.2.

5.12.8.1.4 For a household extraction-type floor cleaning machine, a PFHC intended to be used only with a proprietary fluid and complying with 5.12.8.2 and 5.12.8.3 is not subjected to the test of 5.12.8.1.2. See also 2.2, 12.2.7(i), and Table 11.1, Item 16.

5.12.8.1.5 In the application of 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.

5.12.8.1.6 An attachment intended to facilitate a cleaning operation with liquid and intended to be stored on the appliance, shall be placed on the appliance in the intended storage position(s) during the test of 5.12.8.1.2.

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 5.12.8.1.3 and 5.12.8.1.4, 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 5.12.8.1.1.

a) One sample shall be subjected to the mold stress-relief distortion test as described in 5.21.3; and

b) One sample shall be subjected to an impact test as described in 5.19.2 or 5.19.3, as follows:

1) For a floor-supported appliance, the impact test shall be as described in 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 5.19.2 with the component in its intended position.

c) In addition, for a reservoir intended to be removed from the appliance for filling and emptying, the drop impact test described in 5.19.2 shall be conducted on the reservoir separate from the appliance with the reservoir filled to maximum capacity, or to its fill line, if provided, with water prior to each drop.

5.12.8.2.2 In determining compliance with the requirements specified in 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 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.

5.12.8.2.3 After the mold stress and impact tests, the evaluation of 5.12.8.2.2 is not required and the leakage current and electric strength tests are not required if there is no water leakage from the PFHC. 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 only with proprietary fluids – PFHC conditioning

5.12.8.3.1 Reservoir, tank, tubing, and similar

5.12.8.3.1.1 With reference to 5.12.8.1.4, if deterioration, breakage, or the like of a PFHC intended for use only 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 5.12.8.1.1 (a) and (c).

5.12.8.3.1.2 Except for a part such as a boot, diaphragm, seal or gasket complying with 5.12.5.2, three samples of the PFHC shall be subjected to the one of the following tests:

a) The cycled fluid conditioning specified in 5.12.8.3.1.6;

b) The static fluid conditioning specified in 5.12.8.3.1.7;

c) The boiling immersion conditioning specified in 5.12.8.3.1.8; or

d) The immersion conditioning specified in 5.12.8.3.1.9.

5.12.8.3.1.3 The test fluid shall be a solution consisting of three times the recommended concentration of the proprietary fluid in water or, for a part containing only the proprietary fluid during normal operation, the test solution shall consist of 100 % proprietary fluid. Except as specified for 5.12.8.3.1.8, 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.

5.12.8.3.1.4 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.

5.12.8.3.1.5 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).

5.12.8.3.1.6 If a pump is used for the cycled conditioning specified in 5.12.8.3.1.5, 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 5.12.8.3.1.7 until the remaining time of the 7-day conditioning is complete.

5.12.8.3.1.7 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.

5.12.8.3.1.8 Three samples of the PFHC shall be immersed in a boiling solution of the test fluid for 7 days. The test equipment shall be capable of maintaining the solution at the required concentration for the entire 7 days of boiling conditioning.

5.12.8.3.1.9 Three samples of the PFHC shall be immersed in a solution of the test fluid for 1000 h.

5.12.8.3.1.10 In determining compliance with the requirements specified in 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 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.

5.12.8.3.1.11 After the conditioning, the evaluation of 5.12.8.3.1.10 is not required and the leakage current and electric strength tests are not required if there is no water leakage from the PHFC. 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 only 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 only with a proprietary fluid and that employs polymeric fluid-handling parts shall be conditioned as described in 5.12.8.3.2.3. 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 5.12.8.3.2.3. After the conditioning, the appliance shall comply with the requirements in 5.12.8.1.1.

5.12.8.3.2.2 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.

5.12.8.3.2.3 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 in water or, for a pump containing only the proprietary fluid during normal operation, the test solution shall consist of 100 % 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.

5.12.8.3.2.4 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.

5.12.8.3.2.5 In determining compliance with the requirements specified in 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 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 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 5.12.8.4.3. As a result of the test, there shall be no leaking or the tubing sample shall be installed in the appliance and subjected to the test specified in 5.12.8.4.2.

5.12.8.4.2 The appliance shall 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 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 5.12.8.1.1 (a) and (c).

5.12.8.4.3 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 5.21.3; and

c) For tubing for use only with a proprietary fluid, two samples after the conditioning as described in 5.12.8.3.1.2.

5.12.8.4.4 As an alternative to the tubing pressure test of 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 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 electric strength test as specified in 5.11. As a result of the test, the sample shall comply with 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 5.12.9.2 – 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 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 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 electric strength test (see 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 5.12.2.2).

5.13 Stability

5.13.1 An appliance as mentioned in 4.19.5.1 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 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 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 4.5.3.3, 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 electric strength 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 electric strength and strain-relief tests. The value of the applied potential shall be as indicated in 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 5.14.1 and the electric strength test specified in 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 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 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 5.15.1. The control shall be additionally subjected to the 6,000-cycle endurance test specified in 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 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 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 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 electric strength 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 Except for appliances provided with cord reels, the power-supply cord of a portable appliance shall be subjected to the test specified in 5.17.3 – 5.17.7. As a result of the test, there shall not be:

a) Short circuit between the conductors (see 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

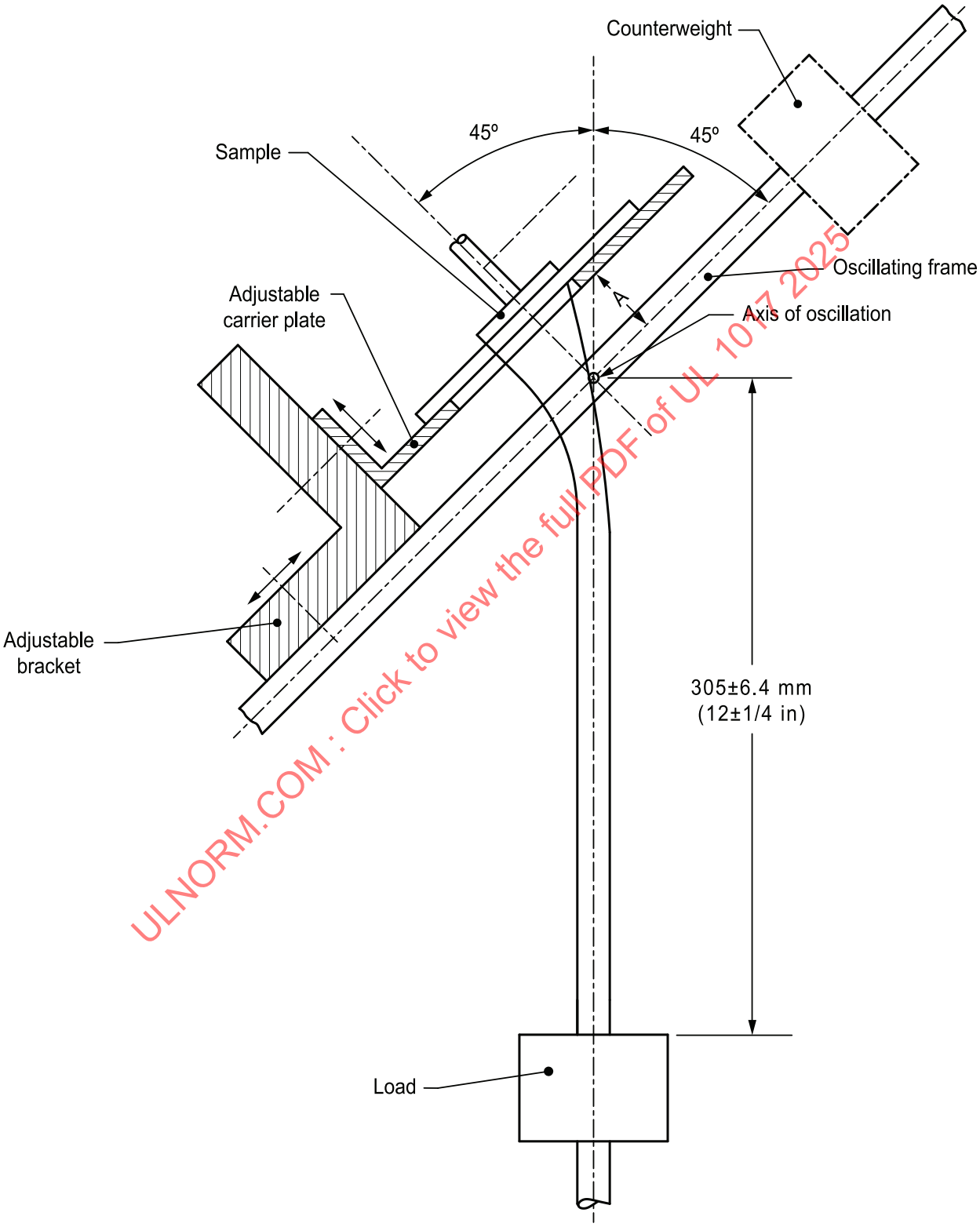
f) Broken strands piercing the insulation and becoming accessible.

5.17.2 With reference to 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 5.4, 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 5.4, 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.

Figure 5.4

Apparatus for Cord Flexing Test



5.17.4 The load shown in Figure 5.4 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 4.7.5.5, after being subjected to the test specified in 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 5.11, electric strength test, with the wiring under test wrapped in metal foil; and

d) Not exceed the temperature limit specified in Table 5.3 for the wiring under test when subjected to a repeat temperature test in accordance with temperature, 5.8 or, for an upright type vacuum cleaner, breakage of no more than 10 % of the strands of any conductor of the wiring routed between the handle and the base.

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 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 5.18.2(a) followed by 1000 cycles of flexing to the position specified in 5.18.2(b). Commercial appliances shall be subjected to 45,000 cycles of flexing to the position specified in 5.18.2(a), followed by 5000 cycles of flexing to the position specified in 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 4.2.1.4, 4.2.1.6 or 5.21.4, shall withstand the impacts described in 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, 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 electric strength test, 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 11.4.28; and

d) The appliance is provided with the instructions specified in 12.5.20.

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 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 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 5.5 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,4.15;

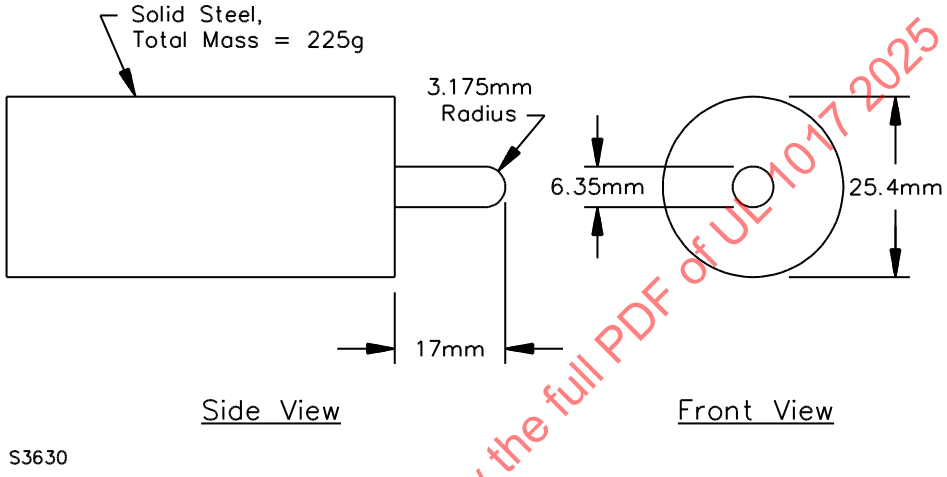
b) Insulated or uninsulated live parts shall not be exposed as determined by accessibility of live parts, 4.2.5;

c) A switch shall remain mounted (see 4.3.1); and

d) For an appliance provided with double-insulation, the double-insulation system shall remain intact.

Figure 5.5

Impactor



5.19.5 Deflection

5.19.5.1 An appliance employing a metal enclosure in accordance with 4.2.1.4, or 4.2.1.6 shall be subjected to the deflection test specified in 5.19.5.2, and shall comply with 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 Except for appliances for marine installations only as specified in 11.4.31, 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.

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 Except for appliances for marine installations only as specified in 11.4.31, 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.

5.19.7.2 The sample used for the Vibration Test, 5.19.6, shall be used for this test. The sample shall be mounted on the platform of a shock machine, as specified in 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, 5.8, and the electric strength test, 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 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 4.19.6.1, 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 Except as specified in 5.21.1.2 or 5.21.1.3, the volume resistivity of the polymeric material shall be:

a) Not less than 50 MΩ-cm after conditioning for 40 h at 23 ±2 °C (73 ±4 °F) and 50 ±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 ±5 % at a temperature of 35 ±2 °C (95 ±4 °F).

5.21.1.2 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 4.15.

5.21.1.3 In lieu of volume resistivity, compliance with the end-product leakage-current requirements (5.3) is acceptable. Leakage current measurement shall be taken from accessible surfaces of the polymeric material in question.

5.21.1.4 The volume resistivity shall be determined in accordance with UL 746A.

5.21.2 Resistance to hot-wire ignition

5.21.2.1 A polymeric material shall be spaced 12.7 mm (1/2 in) or more from electrically live parts, including internal wiring, or shall comply with the following:

a) The Hot wire ignition test specified in UL 746A, resisting ignition for:

1) 7 s or longer (PLC 4 – see note a of Table 4.4) for portable appliances; or

2) 15 s or longer (PLC 3 – see note a of Table 4.4) for stationary or fixed appliances,

b) The Abnormal overload test, 5.26;

c) The Glow-wire end-product test, 5.27; or

d) 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 4.5 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 4.5 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 Except for parts formed of rigid thermosetting materials or low-pressure foamed molded parts, conditioning of the appliance as described in 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, 4.15;

b) Making uninsulated live parts or internal wiring accessible to contact as determined by accessibility to live parts, 4.2.5;

c) Causing a condition that results in the appliance not complying with the power-supply-cord strain-relief requirements in 5.21.6, if applicable; or

d) Defeating the integrity of the enclosure so that mechanical protection in accordance with 4.2.1 is not afforded to internal parts of the appliance.

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 5.21.3.1.

5.21.4 Impact

5.21.4.1 The appliance shall be subjected to the applicable impact described in 5.19.

5.21.4.2 Each of three samples of an appliance intended for outdoor use shall be cooled to a temperature of minus 35.0 ±2.0 °C (minus 31.0 ±3.6 °F) and maintained at this temperature for 3 h. However, for an appliance marked in accordance with Item 3, 5 or 11 of Table 11.1, the conditioning temperatures shall be 0 ±2 °C (32 ±3.6 °F). While the unit is still cold, the samples shall be subjected to the applicable impact described in 5.19.

5.21.5 Severe conditions

5.21.5.1 An appliance shall be conditioned as described in 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 5.21.3.1 (a), (b), and (d).

5.21.5.2 For an appliance conditioned as described in 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 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 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 5.9.1.1 and 5.21.5.4.

5.21.5.4 An appliance as described in 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, unless the product employs a flow-through type vacuum motor, 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. The location of the blockage of the air intake shall be determined in accordance with 5.2.2.1.

5.21.5.5 During the conditioning mentioned in 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 CSA 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 CSA C22.2 No. 24 and UL 60730-2-9, 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 4.9.3.10.

c) A temperature limiter that complies with 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, may be retained in the circuit.

d) An electronic temperature control that complies with 4.11.4 may be retained in the circuit.

e) A mechanical air-flow valve that functions during the blocked inlet test of 5.21.5.4 shall comply with the endurance test requirements specified in 5.30.

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 5.21.3, the sample shall be subjected to the strain-relief test, 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 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.

5.21.7.3 If a manual or automatic reset motor-protective device operates during the test, the test shall be continued for four operations (three resets, four trips) of a manual reset protective device or until ultimate results for an automatic reset protective device. The protective device shall then be defeated, except for electronically commutated motors, and the test continued until ultimate results, unless the device consists of one of the following:

a) A thermally protected motor or electronically protected motor complying with 4.9.3.2 or 4.9.3.4, respectively.

b) A electronic protective control suitable for the horsepower or full-load and locked rotor current of the load controlled complying with 4.11.4.

c) An electromechanical temperature-sensitive device, such as a thermostat, with a suitable horsepower rating or full-load and locked rotor current ratings, a minimum endurance level of 6000 cycles, and complying with the requirements for:

1) An automatic or manual reset appliance temperature limiting control in CSA C22.2 No. 24 and UL 60730-2-9; or

2) A thermal cut-out in CSA-E60730-2-9 and UL 60730-2-9.

d) A supplementary protector, with a suitable horsepower rating or full-load and locked rotor current ratings and complying with CSA C22.2 No. 235 and UL 1077.

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 11.1 shall be acceptably resistant to degradation when exposed to ultraviolet light in accordance with UL 746C.

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 5.21.9.2 without resulting in any of the following:

a) Reduction of spacings below the minimum values specified in 4.15;

b) Accessibility to contact of uninsulated live parts of internal wiring;

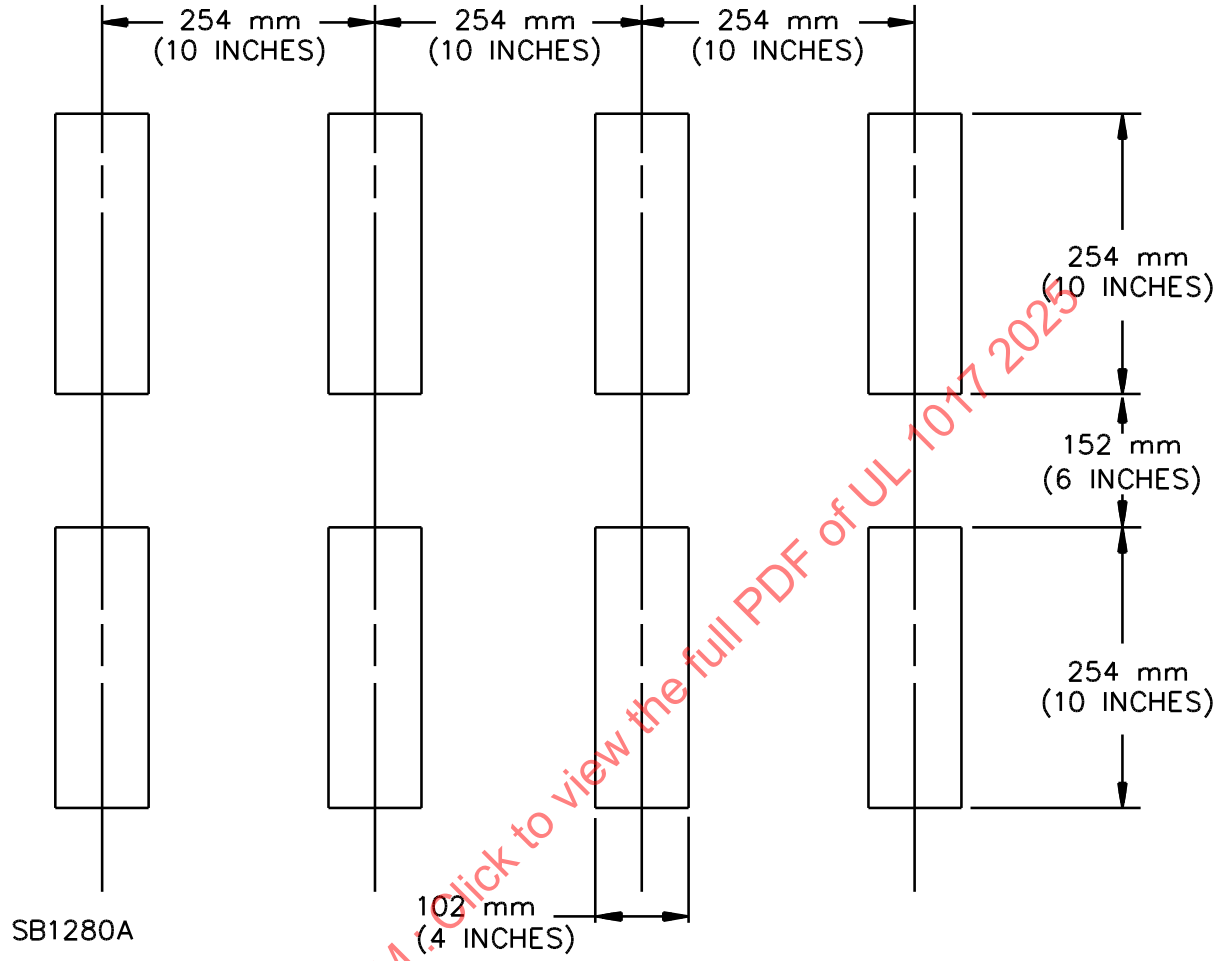
c) Such breakage, cracking, rupture, and the like as to adversely affect the insulation; or

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 5.6.

Figure 5.6

Location of Applicators for Crush-Resistance Test



5.21.10 Thermal aging

5.21.10.1 A material used for the enclosure or an insulating material supporting, in contact with or close proximity to live parts as specified in 4.8.2 shall be resistant to thermal degradation at the maximum temperature to which it is exposed during normal use of the appliance.

5.21.10.2 The material shall have a relative thermal index, based on historical data or a long-term thermal aging program, in accordance with CSA C22.2 No. 0.17 and UL 746B, which indicates acceptability for use at the temperature involved unless the material is used for the enclosure and the maximum temperature to which it is exposed during normal use of the appliance does not exceed:

a) 80 °C (176 °F) for an attended, intermittent-duty household use appliance;

b) 65 °C (149 °F) for any other portable appliance; and

c) 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 5.19.2 or 5.19.3 the mold stress-relief distortion test, 5.21.3. As a result of the impact and mold stress-relief distortion tests, 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. Unless the material also serves as a part of the enclosure or as electrical insulation as specified in 4.8.2, the remaining requirements in 5.21 are not applicable.

5.22.2 The requirement in 5.22.1 does not apply to polymeric materials 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 4.2.4 shall be subjected to the tests specified in 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.

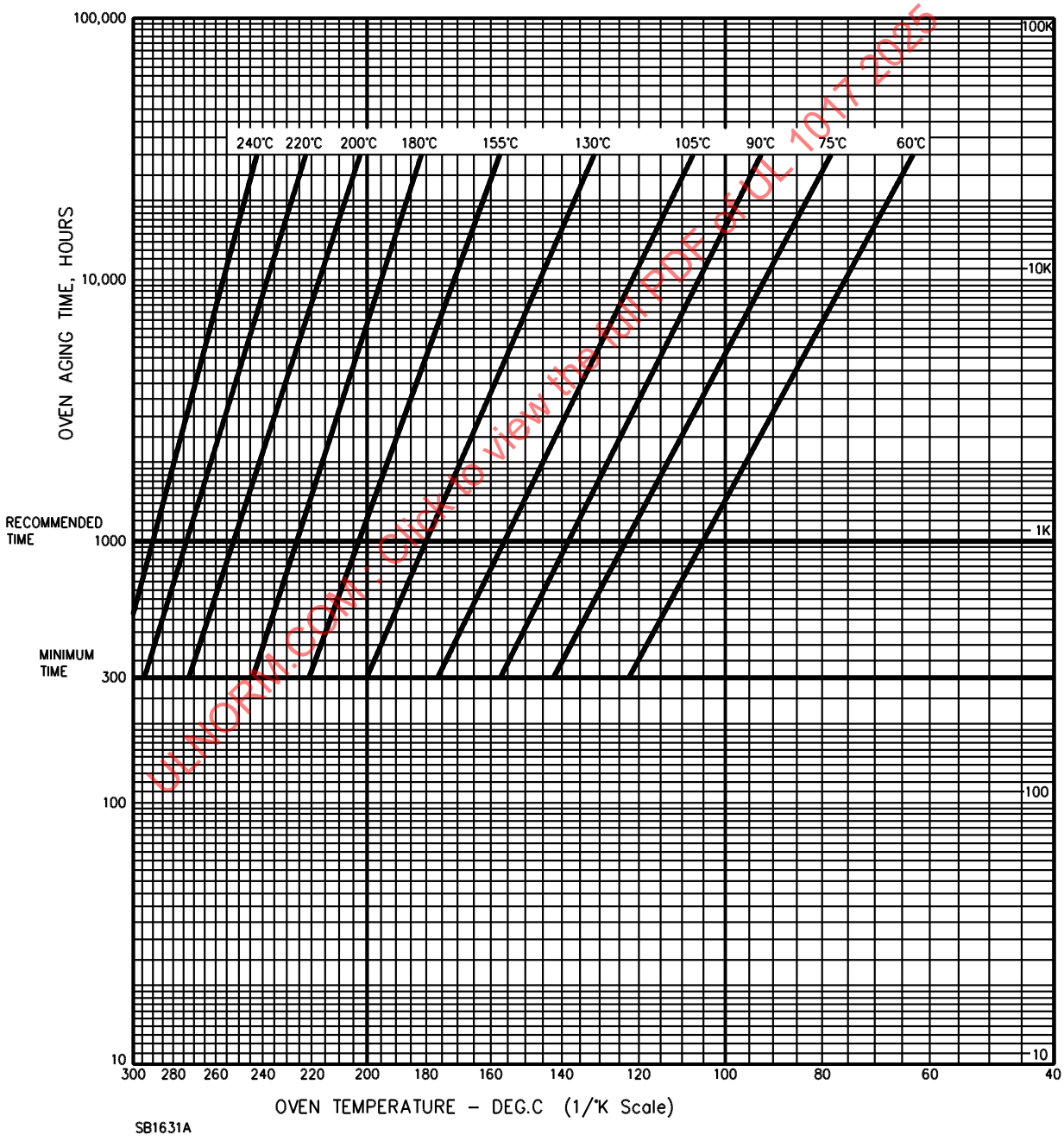
5.23.2.2 The specimens shall be subjected to applicable tests to determine the value of the bond-strength in the as-received condition. Specimens that break at an obvious flaw remote from the adhesive line shall be discarded and a retest conducted. The average value of the bond-strength shall be computed. This value shall be used for comparison with values for bond-strength after the environmental conditioning described in 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 5.7, where the temperature index T is the measured normal operating temperature (see 5.8) of the adhesive, but not less than 60 °C (140 °F). On the same thermal-endurance-profile line in Figure 5.7, 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.

Figure 5.7

Conditioning Time Versus Oven Temperature for Temperature Index of Adhesives



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 ±1 °C (140 ±1.8 °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 5.6.

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.

Table 5.6
Cycling Conditions

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).	

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 minus 35 ±1 °C (minus 31 ±1.8 °F) for outdoor-use applications and at 0 ±1 °C (32 ±1.8 °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 5.24.2 and 5.24.3, unless the motor complies with the double insulation requirements specified in 6.16 and 6.17 or the motor complies with one of the following standards:

a) UL 1004-1; or

b) CSA C22.2 No. 77 and UL 1004-2; or

c) CSA C22.2 No. 77 and UL 1004-3.

5.24.2 Abnormal conditioning

5.24.2.1 The motor shall be subjected to the abnormal conditioning described in 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 electric strength test specified in 5.11 immediately following the conditioning specified in 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 Unless the motor serves to move air only with a direct mounted fan, 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 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 electric strength test specified in 5.11 immediately following the overload-burnout conditioning.

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.

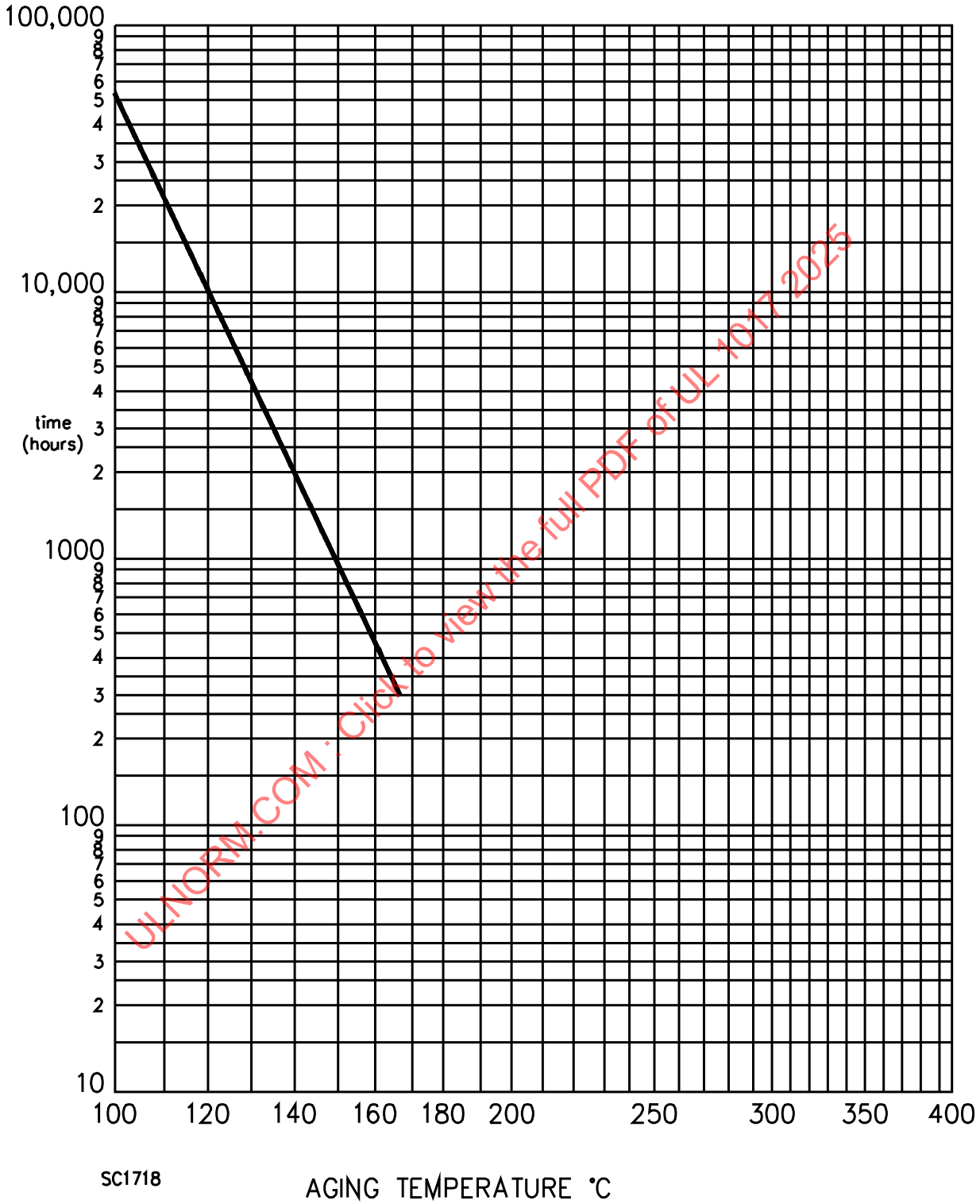
5.24.3.3 For household use floor finishing machines, each of three samples of the complete product shall be subjected to operation at no load for 1/2 h, immediately followed by operation at normal load for 1/2 h. Immediately following this, the load shall be increased in steps of 10 % of the rated current 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 4.9.1.8 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 5.8. The motor insulation system shall cool to room temperature and the applicable electric strength test specified in 5.11 shall be applied between live parts and noncurrent-carrying metal parts that are isolated from each other by the material under consideration.

Figure 5.8

Class 105 (A) System Response



5.25 End-product arc resistance

5.25.1 A polymeric material employed in accordance with 4.8.2 shall be tested as specified in 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 CSA C22.2 No. 0.17 and UL 94. In addition, there shall not be a permanent conductive carbon path judged by application of an electric strength potential between the live part and the adjacent part of different potential, as required in electric strength test, 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 4.8.2(d)(2) or 5.21.2.1(b) 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 5.7. See 5.26.2 and 5.26.3.

Table 5.7
Abnormal Overload Test

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.

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 4.8.2(d)(4) or 5.21.2.1(c) shall be capable of withstanding the effects of an electrically heated wire as described in the glow-wire end-product test (GWEPT) specified in CSA 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 4.5 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 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, other than a battery-operated 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.

5.28.2.2 A blower cleaner, other than a battery-operated blower cleaner, provided with a series motor and thermoplastic fan shall also be subjected to the test in 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 5.28.2.1 and then investigated for compliance with 5.28.1.1.

5.29 Testing of temperature control devices used in a vacuum with a steam-cleaning attachment

5.29.1 Overload test for automatic temperature controls

5.29.1.1 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 product is connected to a supply circuit having a potential of 120 % of the voltage specified in 5.1.2. There shall be neither electrical nor mechanical malfunction of the control, nor undue burning, pitting, or welding of the contacts.

5.29.1.2 In tests to determine whether an automatic control complies with the requirements in 5.29.1.1, 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 singlepole, 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.

5.29.2 Endurance test for thermostats

5.29.2.1 A thermostat shall be capable of withstanding an endurance test consisting of the number of cycles indicated in Table 5.2. 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.

5.29.2.2 With reference to 5.29.2.1 and Table 5.2, 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.

5.30 Mechanical valve endurance test

5.30.1 With reference to 5.2.1.4, 5.2.2.3, and 5.21.5.5(e), 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.

5.30.2 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.

5.30.3 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 5.30.1 and comply with 5.30.4.

5.30.4 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.

5.31 General purpose transformers

5.31.1 General

5.31.1.1 With reference to 4.1.2.10 in addition to the end-product Temperature Test and electric strength test, a general purpose transformer shall also be subjected to the tests of 5.31.2 – 5.31.4.

5.31.2 Voltage measurement test

5.31.2.1 For purposes of comparison with voltages measured as described in the Overload Test of 5.31.3, each secondary open-circuit voltage shall be measured with the primary connected to a test voltage and frequency supply source as indicated in 5.1.

5.31.3 Overload test

5.31.3.1 A transformer shall be subjected to the test conditions described in 5.31.3.2. 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 5.31.2. As an option, a protective device, if provided, may be bypassed when conducting this test.

5.31.3.2 The transformer shall be operated as described in the Temperature Test in 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 5.31.3.1. 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.

5.31.3.3 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.

5.31.3.4 A protective device, when provided, shall be bypassed when the device opens while the load is adjusted after the surface temperatures have stabilized.

5.31.4 Repeated electric strength test

5.31.4.1 Following the Overload Test in 5.31.3, the transformer shall be subjected to a repeated electric strength test. The test potential shall be 65 % of the value originally specified. After this test, the transformer shall perform as intended.

5.32 Testing of overmolded pin and sleeve assemblies

5.32.1 General

5.32.1.1 Pin and sleeve assemblies as described in 4.5.2.3 and 4.7.5.8 and mounted in their respective appliance housings shall additionally be tested as described in 5.32.2 – 5.32.3. Conditioning of the pin and sleeve assembly 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 or damage that results in any of the following:

a) Wear impairing its further use;

b) Deterioration of enclosures or barriers;

c) Damage to the entry holes for the pins that might impair proper working;

d) Loosening of electrical or mechanical connections;

e) Seepage of sealing compound;

f) Ignition of the enclosure material;

g) No flashover between live parts of different polarity or between such parts and parts of the earthing circuit, if any; and

h) There shall be no sustained arcing.

5.32.2 Endurance

5.32.2.1 Pin and sleeve assemblies shall withstand, without excessive wear or other harmful effects, the mechanical, electrical and thermal stresses occurring in normal use. Compliance is checked by testing connectors in the apparatus described in 5.32.2.2 – 5.32.2.3. Pin and sleeve assemblies are connected and disconnected 1,000 times at rated current and 3,000 times without a load. Connections intended to be connected permanently or semi-permanently, except for replacement or maintenance, the number of cycles at rated current is reduced to 100. No unloaded cycling is required.

5.32.2.2 The parts of the appliance holding the pin and sleeve assemblies are mounted in an appropriate test apparatus. The opposing parts are positioned so that the plane through the axes of the pins is horizontal and the ground pin, if any, is uppermost. If present, the ground circuit is connected to ground.

5.32.2.3 The test setup shall be adjusted so as to simulate as far as possible disconnection in normal use. The sleeve assembly is connected to a voltage supply source representative of the application.

5.32.2.4 The pin and sleeve assemblies are connected and disconnected at a minimum rate of 6 cycles per minute. The length of a stroke of the test apparatus is adjusted to provide maximum insertion of the two parts of the appliance. No current is passed through the ground circuit, if present.

5.32.2.5 For pin and sleeve assemblies incorporating a ground pin, the test is repeated with the ground pin connected to one of the poles of the supply. It is operated for half the number of cycles at rated current.

5.32.2.6 After the test, the specimens shall withstand an electric strength test as specified in 5.11.

5.32.3 Temperature rise

5.32.3.1 Pin and sleeve assemblies shall prevent excessive temperature rise when operated under conditions of use.

5.32.3.2 Temperatures of the pin and sleeve assembly are measured by means of thermocouples placed as close to the connection as possible.

5.32.3.3 The parts of the appliance containing the pin and sleeve assemblies are assembled as in normal use. A current equal to 1.25 times the rated or measured current, whichever is higher, is passed through the pin and sleeve assembly for a period of one hour.

5.32.3.4 For pin and sleeve assemblies incorporating a ground pin, the test is repeated with the current passing through one of the live conductors and the ground pin.

5.32.3.5 During the tests the temperature rise shall not exceed 45 °C.

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 4.16.1. These requirements supplement those contained elsewhere in this Standard.

6.2 Definitions

6.2.1 See Section 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.

A construction using reinforced insulation complying with 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 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 6.4; and

c) Basic insulation itself, unless it is reinforced insulation as described in 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 6.1, unless loosening or displacement of the part causes malfunctioning of the appliance and does not result in a live part being made accessible.

Table 6.1
Minimum Spacings

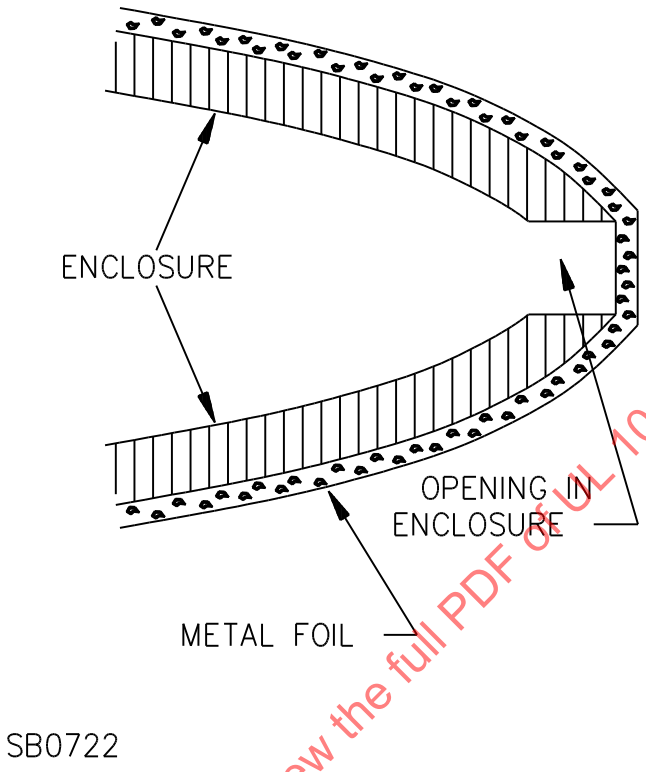
	Parts between which spacings are measured	Minimum acceptable spacings
1.	Uninsulated live parts and noncurrent-carrying metal parts that are separated by basic insulation only.[a]	Not less than the through air and over surface spacings specified in 4.15
2.	Accessible noncurrent-carrying metal parts[b] 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 4.15
3.	Uninsulated live parts and noncurrent-carrying metal parts[b] separated by double insulation or by reinforced insulation, where acceptable, except as specified in Item 4.	Not less than twice the through air and over surface spacings specified in 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 4.15.1.7.

[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 6.1.

Figure 6.1

Method of Covering Enclosure with Foil for Measurement and Tests



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 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 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, except for the wiring terminals of the brush itself, shall be enclosed in the enclosure of insulating material; and

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, 6.18.

6.4.5.2 If any of the constructions described in 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 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 3.19, 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 6.1.

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 6.1, unless 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.

6.11.2 Compliance with 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 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. However, 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 5.3, leakage current, 5.4, leakage-current following humidity conditioning, and 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 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, 5.4, may be used for several tests. The sequence of testing following humidity conditioning shall be:

a) Leakage current;

b) Insulation resistance (see 6.14); and

c) Electric strength.

6.12.4 For an appliance employing discharge-path resistors, or ground connected radio-interference capacitors except Y1 capacitors complying with UL 60384-14 and CSA E60384-14, as described in 4.2.5.7, the resistors shall be shorted one at a time prior to the test.

6.13 Electric strength test

6.13.1 For the tests specified in electric strength test, 5.11, and electric strength test, 8.4, the points of application and the potentials employed shall be in accordance with Table 6.2.

6.13.2 For an appliance employing discharge-path resistors, or ground connected radio-interference capacitors except Y1 capacitors complying with UL 60384-14 and CSA E60384-14, as described in 4.2.5.7, the connection shall be open-circuited at the point of attachment to the accessible part.

Table 6.2
Points of Application and Voltages for Electric Strength Test

Points between which potential shall be applied		Test potential in V
1.	Live parts and inaccessible noncurrent-carrying metal parts	Voltage prescribed for electric strength test in 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 6.1	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 6.1	2000 V plus twice the rated voltage of the equipment
4.	Accessible noncurrent-carrying metal parts and: 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

6.14 Insulation resistance

6.14.1 The appliance shall be conditioned as described in leakage-current following humidity conditioning, 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 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 6.12.2. See also 6.12.3.

6.14.4 The measurements of insulation resistance and the electric strength test mentioned in 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 electric strength test in 6.13.

6.15 Resistance to impact test

6.15.1 The appliance shall withstand the applicable impact tests specified in 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 electric strength test in 6.13 after being subjected to the impact test.

6.16 Abnormal operation test

6.16.1 Abnormal operation as specified in 5.21.7 shall not affect the insulation to the extent that it does not comply with 6.16.2 or that it exposes live parts. The tests specified in abnormal operation, 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 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 6.1 and Figure 6.1, of the potential specified in Table 6.2.

6.17 Overload test on motors

6.17.1 General

6.17.1.1 Operation of a motor, other than a motor with a pre-filter that serves to move air only with a direct mounted fan, under conditions of extreme overload shall not affect the appliance insulation to the extent that the insulation does not comply with 6.17.4.3 or that live parts are exposed.

6.17.1.2 To determine whether a motor complies with 6.17.1.1, three previously untested samples of the appliance shall be operated as described in 6.17.2.1 for vacuum cleaners with mechanical agitators and motorized nozzles or 6.17.3.1 for household use floor finishing machines.

6.17.2 Vacuum cleaners with mechanical agitators and motorized nozzles

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 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 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 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 6.2 and Figure 6.1; and

b) All inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts or the foil as mentioned in item 2 of Table 6.2 and Figure 6.1.

6.18 Investigation of armature employing reinforced insulation

6.18.1 If a motor construction includes reinforced armature insulation as mentioned in 6.4.5.1(c), each of three samples of the armature, after each of three conditioning procedures described in 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 6.18.1 shall first be conditioned in an oven for 500 h at a temperature of:

a) 120 °C (248 °F) for a Class A system;

b) 140 °C (284 °F) for a Class B system;

c) 175 °C (347 °F) for a Class F system; or

d) 200 °C (392 °F) for a Class H system.

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 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, 5.12, the appliance shall:

a) Comply with the leakage-current test, 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 6.1 and Figure 6.1.

6.20 Manufacturing and production tests

6.20.1 Production line electric strength 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 6.3 in accordance with the test method described in electric strength test, 10.1.

Table 6.3
Production-Line Electric Strength Test Potentials

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:		
	a) body supported wet pick-up appliance	3000	4242
	b) all other appliances	2500	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 shall be conducted. Periodic physical-property tests on molded parts shall also be conducted.

7 Rechargeable Battery-Powered Appliances

7.1 General

7.1.1 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 7.1.2 – 7.1.11 below.

7.1.2 In reference to Indent A of Annex D of UL 2595 / CSA C22.2 No. 0.23, except as specified elsewhere in UL 2595 / CSA C22.2 No. 0.23, the following requirements in this end product standard do not apply or are amended as indicated below:

a) The clauses specified in Table 7.1 do not apply.

b) For 5.18, the compliance criteria is as specified in 17.2 of UL 2595 / CSA C22 No. 0.23. The appliance shall remain energized under maximum normal load during the test by one of the following methods:

1) Using a fully charged battery until the applicable number of cycles is completed; or

2) Using a DC power supply set at the maximum voltage.

c) The testing of 5.19 and, for appliances for outdoor use, 5.21.4, applies to the appliance, but the acceptance/compliance criteria of the mechanical strength test in Section 15 of UL 2595 / CSA C22.2 No. 0.23 shall be applied.

d) 5.21.3 is applied, but the ball pressure test in 21.2 of UL 2595 / CSA C22.2 No. 0.23 may be used in place of the Mold Stress Test and the compliance criteria for either test is as specified in UL 2595 / CSA C22.2 No. 0.23.

e) 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) For 8.4.1, the test voltages of 8.16 of UL 2595 / CSA C22.2 No. 0.23 shall be applied.

g) For 11.4.7, 11.4.18, 11.4.21, 12.2, and Table 11.1, the marking or instruction requirements that pertain to the risk of electric shock only apply to products operating at hazardous voltages (e.g. Items 1 – 13 and 16). Items related to the risk of fire or explosion (e.g., items 14, 15, and 16 of Table 11.1) shall apply as indicated.

h) For 11.4.16 and 11.4.17 and 11.4.18, the statement "Unplug Before Cleaning or Servicing" shall be replaced with "Disconnect Battery Pack Before Cleaning or Servicing", or the equivalent and the battery operated appliance shall incorporate a means for disconnecting the battery(s) without the use of tools. With respect to 11.4.16, an appliance provided with a reliable off position and the power switch is provided with a means to prevent actuation, in order to prevent inadvertent operation during servicing, shall replace the statement “Unplug Before Servicing” by “Engage Power Switch Lock-off Before Servicing” or the equivalent. This marking is not required if the means to prevent actuation of the power switch is self-restoring when the power switch actuator is put into the off position.

Note: A switch complying with Section 18 of UL 2595 / CSA C22.2 No. 0.23 or an electronic control with an off condition evaluated as a safety critical function are considered to provide a reliable off position.

i) Requirements pertaining to “live” parts or “live” conductors are applicable where failure could result in risk of fire, electric shock, or failure of a safety critical function.

Table 7.1
Requirements Not Applicable for Battery-Powered Appliances

Title	Clause
General	2.1.3
Components	4.1.2 except 4.1.2.1 for appliance markings
Enclosures	4.2.1.8 – 4.2.1.11, 4.2.2, 4.2.3 except 4.2.3.5, 4.2.3.6, and 4.2.5
Mechanical Assembly	4.3.1.3
Supply connections	4.5.1, 4.5.3, 5.5.4 and 4.5.5
Internal wiring and external interconnections	4.7.1, 4.7.2, 4.7.3 and 4.7.4
Electrical insulation	4.8

Table 7.1 Continued on Next Page

Table 7.1 Continued

Title	Clause
Motors	4.9
Switches, relays, and similar controls	4.10, except 4.10.3
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	4.17.5 – 4.17.16, 4.17.18 and 4.17.19
Heating elements / steam generators	4.18
Protection against injury to persons	4.19.4
Tests, General	5.1.2 and 5.1.3
Normal loads	5.2
Leakage current	5.3 – 5.5
Starting current	5.6
Rating	5.7
Temperature	5.8
Severe operating conditions	5.9
Abnormal operation	5.10, except for Ash Vacs 5.10.8
Electric strength test	5.11
Resistance to moisture	5.12.9
Switches, relays, and similar controls	5.15
Internal wiring and interconnecting cord flexing	5.18.1
Polymeric enclosure parts	5.21.1, 5.21.2, 5.21.3.1, 5.21.5 – 5.21.7, and 5.21.9
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
Testing of temperature control devices used in a vacuum with a steam-cleaning attachment	5.29.1
Mechanical valve endurance test	5.30
General purpose transformers	5.31
Testing of overmolded pin and sleeve assemblies	5.32
Double Insulation	Section 6
Leakage-current test (Current carrying hoses and accessory electrified wall valves)	8.5
Manufacturing and Production Tests	Section 10
Marking	11.1.4, 11.1.6 and 11.4.22 – 11.4.24
Instruction Manual	12.2.11, 12.2.12, 12.3, 12.4, 12.5.2 – 12.5.6, 12.5.9 – 12.5.10, and 12.5.13 – 12.5.18

7.1.3 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 extraction type floor cleaning machine.

7.1.4 With respect to Indent C of Annex D of UL 2595 / CSA C22.2 No. 0.23, LT specification shall be required for batteries for products not marked intended for indoor use; and ELT: −35 °C specification shall be required for batteries for products not marked “Use Indoors” or “Store Indoors”.

7.1.5 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.

7.1.6 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 / CSA C22.2 No. 0.23 are considered suitable.

7.1.7 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 / CSA C22.2 No. 0.23, the appliance shall be operated with the intake ports uncovered and with no additional mechanical load for those tests where applicable. In addition to the abnormal conditions specified in UL 2595, vacuums with a steam cleaning function, shall also be operated dry continuously with all automatic temperature controls or protective devices shunted out of the circuit, except as specified in 5.2.8.5, until ultimate results. If provided, low water sensing circuits not evaluated as safety critical functions shall also be defeated.

7.1.8 With respect to Indent G of Annex D of UL 2595 / CSA C22.2 No. 0.23, the safety-critical functions (SCFs) identified in Table 7.2 of this end product standard replace those specified in UL 2595 / CSA 22.2 No. 0.23. In addition, all safety critical functions shall be maintained at any operating voltage (including battery low voltage) and meet requirements of 16.15 of UL 2595 / CSA C22.2 No. 0.23.

Table 7.2
Safety-Critical Functions (SCFs) for Battery-Operated Appliances

Type and purpose of SCF	Required performance level (PL)
Prevent unwanted turning on where unexpected operation exposes users or bystanders to accessible hazardous moving parts.	B
Provide desired switch-off of the appliance if continued operation exposes the user to moving parts.	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 due to accessible moving parts.	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 reverse direction of rotation	Not a SCF
Prevent self-resetting as required by 4.19.7.3 where unexpected operation exposes users or bystanders to a substantial risk of injury due to accessible hazardous moving parts.	B
Prevent unwanted wetting of uninsulated live parts as defined in 5.12 of this end-product standard (e.g. electronic float sensor).	C
Prevent operation under conditions of moisture leakage.	B

7.1.9 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.

7.1.10 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.

7.1.11 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 / CSA C22.2 No. 0.23, 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 7.1.2(a) of this end-product standard might be applicable.

7.1.12 With respect to Indent K of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the conditioning of the appliance with respect to moisture resistance shall be as in 5.12 as applicable, the acceptance criteria of 5.12 being replaced by those specified in 26.3 and 26.4 of UL 2595 / CSA C22.2 No. 0.23. Separable or detachable battery packs for appliances covered by this Standard require no additional testing of the battery pack to liquid ingress other than that which would be experienced in testing as attached to the appliance.

7.2 Automatic battery-powered floor cleaners

7.2.1 The requirements in 7.1.2 additionally apply to automatic battery-powered floor cleaners.

7.2.2 In the application of 6.7 of UL 2595 / CSA C22.2 No. 0.23, an automatic battery-powered floor 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.

7.2.3 With respect to Indent A of Appendix D of UL 2595 / CSA C22.2 No. 0.23, in the application of 12.2.6 and 12.2.7 of this end-product standard, an automatic battery-powered floor 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 allow the appliance to operate in an area with an unattended infant/child or where someone is laying on the floor.

c) Do not operate the appliance in an area where there are lit candles or fragile objects on the floor to be cleaned.

d) Do not operate the appliance in a room that has lit candles on furniture that the appliance may accidentally hit or bump into.

e) Do not allow children to sit on the appliance.

f) Do not use the appliance on a wet surface (if intended for dry pick-up only).

g) Be aware of the potential trip hazard in the area an automatic floor cleaner is being operated.

7.2.4 With respect to Indent D of Appendix D of UL 2595 / CSA C22.2 No. 0.23, during the heating test, automatic battery-powered floor cleaners shall be operated on the test carpet described in 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.

7.2.5 With respect to Indent G of Appendix D of UL 2595 / CSA C22.2 No. 0.23, additional safety-critical functions (SCFs) for automatic battery-powered floor cleaners are in Table 7.3 of this end-product

standard. In addition, all safety critical functions shall be maintained at any operating voltage (including battery low voltage) and meet requirements of 16.15 of UL 2595 / CSA C22.2 No. 0.23.

Table 7.3
Additional Safety-Critical Functions (SCFs) for Automatic Battery-Powered Floor Cleaners

Type and purpose of SCFs	Minimum performance level (PL) per ISO 13849-1
Power on/off (7.2.10), except as specified in Table 7.2.	Not a SCF
Hazard from moving part (7.2.11)	B
Fall hazard from automatic battery-powered floor cleaner (7.2.13)	B
Impact hazard from automatic battery-powered floor cleaner (7.4.1.)	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
Moisture detection required for compliance with 7.2.9	B

7.2.6 With respect to Indent H of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the robot vacuum part of an automatic battery-powered floor cleaner shall be subjected to an evenly distributed load of 60 kg (130-lbs) placed on top of the floor cleaner for a period of one minute. This test shall be conducted on three samples of the appliance. 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.

7.2.7 With respect to indent K of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the robot vacuum part of an automatic battery-powered floor cleaner shall be conditioned as in 7.2.8 – 7.2.9 for unintentional pickup of liquid or accidental spillage of liquid onto the appliance and assessed as indicated in Indent K. After the tests the appliance shall be returned to the dock if still operable and reassessed with respect to any charging functions using the acceptance criteria indicated in Indent K.

7.2.8 An automatic battery-powered floor cleaner shall be operated on the hard surface described in 5.2.9.2 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 hard floor surface to limit the area of operation with 500 mL of 1 % NaCl solution poured over the surface prior to the automatic battery-powered floor cleaner operating.

7.2.9 The appliance shall be placed in its normal operating position. Using a graduated cylinder, 500 mL distilled water with 0.6 g/L of sodium chloride and 5.4 g/L of a low sudsing detergent shall be poured over the areas on the top surface of the appliance where water is likely to enter the appliance.

7.2.10 When conducting resistance to moisture tests in 5.12, the appliance shall be returned to its docking station upon completion of the test if it is still operable. In addition, the tests of 5.12.4 and 5.12.8 shall be conducted with and without the appliance on its docking station as applicable.

7.2.11 The mobile part of automatic battery-powered floor cleaners shall be provided with a readily accessible manually operated switch to turn all the motors off. Initial actuation of the switch shall cease all operation of the motors and the appliance shall remove power to the motors within a specified time period in accordance with the instructions. Reactivation shall only be possible by manual reset on the mobile part by the user.

7.2.12 If the compliance of 7.2.13 – 7.4.5 relies on the operation of a safety critical function electronic circuit, compliance should be demonstrated with respect to Indent G of Appendix D of UL 2595 / CSA C22.2 No. 0.23.

7.2.13 Automatic battery-powered floor cleaners shall be provided with a device to protect the appliance from dropping off the cleaning surface (e.g. stairways and the like). When the vacuum reaches the critical edge, it shall either stop, or move away from the edge and continue its normal vacuuming operation. Compliance shall be checked by test in 7.2.14 – 7.2.19. Consideration shall be given to the use of a testing bed with rollers during the immunity testing required of Indent G of Appendix D of UL 2595 / CSA C22.2 No. 0.23.

7.2.14 Automatic battery-powered floor cleaners shall be operated as defined in 7.2.15, on each of the test tables defined in 7.2.16. Compliance shall be defined by 7.2.19.

7.2.15 Test shall be run according to 9.3 and 9.4 (if applicable) of IEC 62849:2016 with the following modifications: total of 10 minutes of run time in each possible operating mode and will not need to be repeated. The test shall be run in the worst case lighting condition for the appliances using one of the two lighting conditions: 200 ±50 lux, 0.01 ±0.01 Lux. Consideration needs to be given for all loading conditions of the Automatic battery-powered floor cleaner to establish the worst load that should be applied during the test.

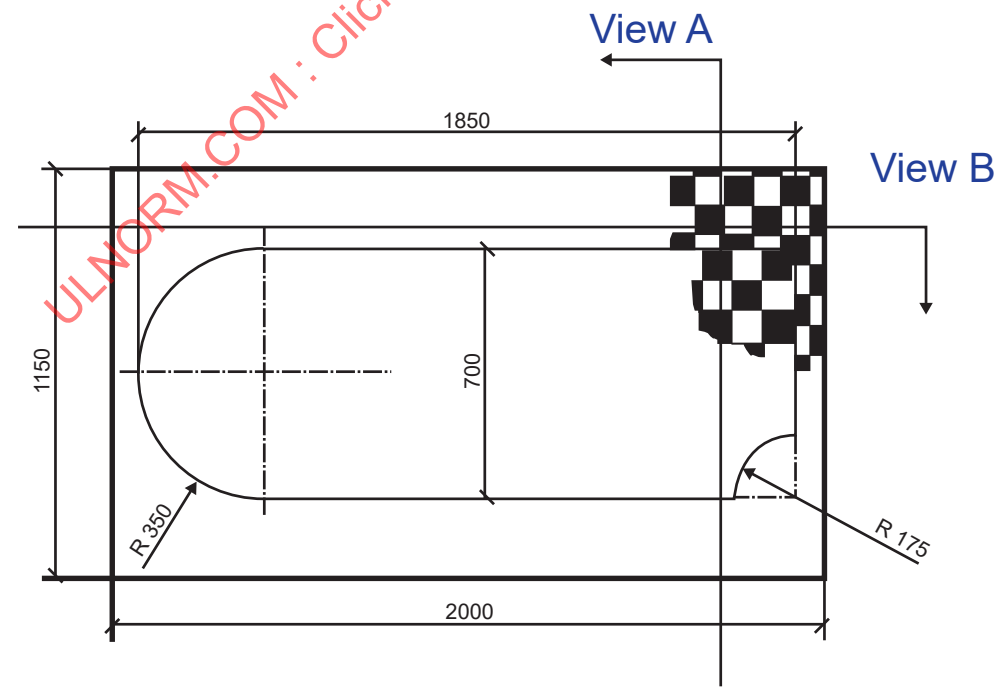
7.2.16 The test table shall be constructed as defined in 9.2 of IEC 62849:2016, with the surfaces as specified in Table 33 only.

7.2.17 The table and base material on which the table stands shall be of the same material.

7.2.18 For checkerboard, the table and the base shall be deliberately misaligned by half a tile in both directions, from the right angle corner (see Figure 7.1).

Figure 7.1

Checkerboard Step and Base



7.2.19 The automatic battery-powered floor cleaners shall have no uncontrolled descent.

7.2.20 Mobile parts of automatic battery-powered floor cleaners shall be equipped with a device to stop movement within 1 s of accessible hazardous moving parts when they lose contact with the surface being cleaned.

7.2.21 Contact of the automatic battery-powered floor cleaner shall not create the potential for injury in normal use. Compliance shall be shown per 7.3.1 or 7.4.1.

7.3 Calculated energy method

7.3.1 The impact energy of the automatic battery-powered floor cleaner is calculated as follows:

$$E = \frac{1}{2}\left(\frac{1}{A} + \frac{1}{m_R}\right)^{-1} V_{max}^2$$

Where:

E = Impact energy (J)

A = (75 kg)

m_R = maximum mass of the appliance, in the most unfavorable configuration allowed by the instruction manual, with the collection bin empty. Any tank that is filled at startup shall be full (kg).

V_{max} = maximum speed (m/sec)

7.3.2 The energy shall not exceed 3.54 in-lbf (0.4 Joules). The test shall be conducted in accordance with a test mode that attains maximum speed on carpet (with and against pile) and on a hard surface, in any mode of operation. Any obstruction detection is defeated for the purposes of this test.

7.4 Measurement method

7.4.1 Alternatively to 7.3.1, the impact force shall not exceed the values in 7.4.2 using the method of 7.4.2 and the contact surface shall be designed as in 7.4.5 as to limit the contact pressure.

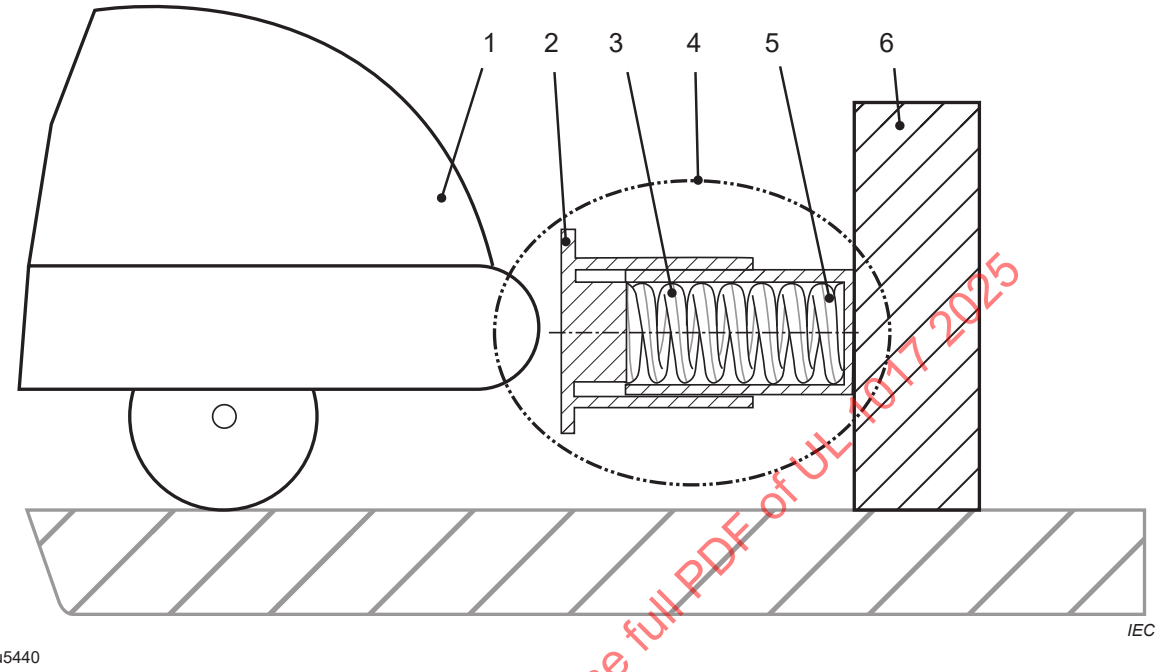
7.4.2 The maximum force applied by the automatic battery-powered floor cleaner against an obstruction shall not be greater than 234 N during the first 0,5 s after impact after a minimum of 45 N is exceeded; and 117 N thereafter.

7.4.3 With respect to 7.4.2, the automatic battery-powered floor cleaner is placed on a level test surface as described in 5.2.9.2. The automatic battery-powered floor cleaner shall be made to collide with a force measuring means described in 7.4.5. The force at impact shall be measured parallel to the ground plane and vertically aligned with the point of contact with the force measuring means. The point of contact shall not be higher than 150 mm from the ground plane. Friction, misalignment and other factors associated with the mounting of the force measuring means shall be such as to minimize the error in the measurement.

7.4.4 The force measurement apparatus consists of an instrument which incorporates a rigid impact plate having a diameter of (90 ±10) mm and a spring having a spring constant of (60 ±2) N/mm. The spring acts on a sensing element which is connected to a measuring instrument having a bandwidth limited to (150 ±50) Hz and with an accuracy of 5 %. The sampling rate shall be at least double of the bandwidth. A typical arrangement of this force measurement apparatus is shown in Figure 7.2.

Figure 7.2

Impact Force – Measurement Method Fixture



Key:

1 = appliance

2 = impact plate

3 = spring

4 = force measuring apparatus

5 = sensing element

6 = rigid support

7.4.5 Potential contact surfaces of automatic battery-powered floor cleaners that would strike an obstruction during use shall fulfill all of the following requirements so as to minimize the risk of injury upon contact:

a) The potential contact surface shall not have a perpendicular protrusion greater than 5 mm unless the protrusion has a:

1) Surface area greater than 20 mm^2; and

2) Minor dimension greater than 5 mm.

b) All protrusions shall have rounded edges; and

c) The surface contacted when striking an obstruction shall be located not greater than 150 mm from the test surface.

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 Sections 1 – 6 and Section 11 of this Standard.

8.1.3 These requirements are not applicable for products where failure of the hose insulation does not result in a risk of fire, electric shock or failure of a safety critical function.

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 external hose structure shall insulate the conductors from contact by the user. In addition, for wet pick-up current-carrying hoses, the internal hose structure shall insulate the conductors. The conductors may be used for structural support of the hose. However, 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 8.18).

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 live 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 8.1. See 8.2.6. In addition, the wall-valve assembly shall comply with the applicable requirements in the following standards:

a) CSA C22.2 No. 18.1 and UL 514A;

b) CSA C22.2 No. 18.2 and UL 514C; and

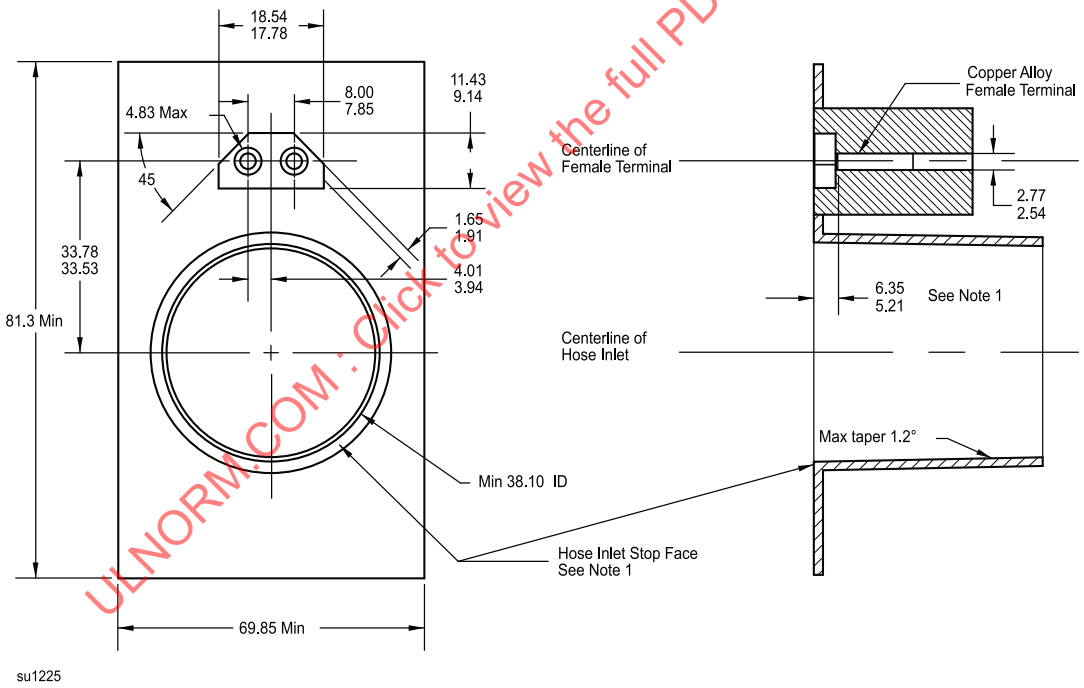
c) CSA C22.2 No. 42.1 and UL 514D.

8.2.4 The configuration of the field wiring leads to the connector of a wall-valve assembly shall be as shown in Figure 8.2.

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 8.3. See 8.2.6.

Figure 8.1

Type A Wall-Valve Configuration



NOTES:

1. The hose inlet stop face is not required to be flush with the inner valve surface. When the inlet stop face is raised, the dimension is referenced from the surface of the raised area of the inlet stop face to the terminal.

2. All dimensions in this figure are in SI units and the inches for the dimensions are:

25.4 mm = 1 in

254 mm = 10 in

Figure 8.2

Female Power Connector Configuration for Type A Wall Valve

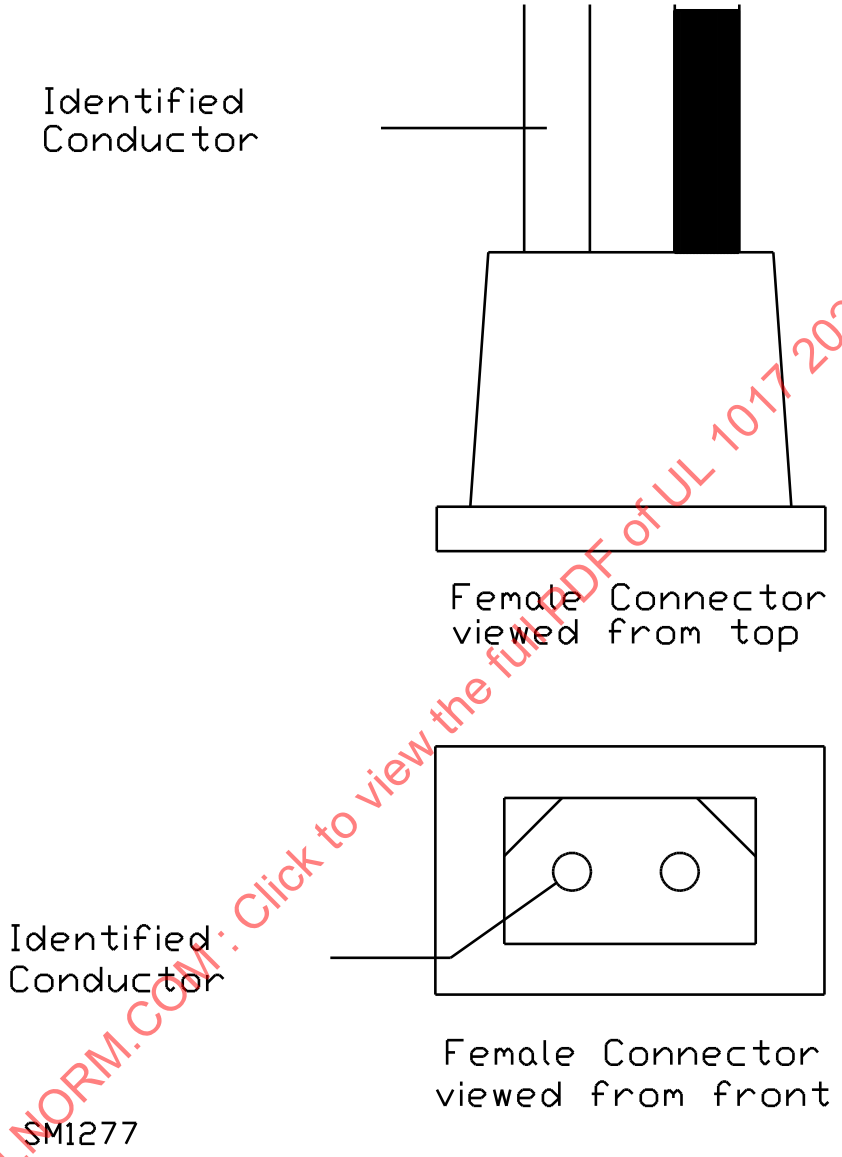
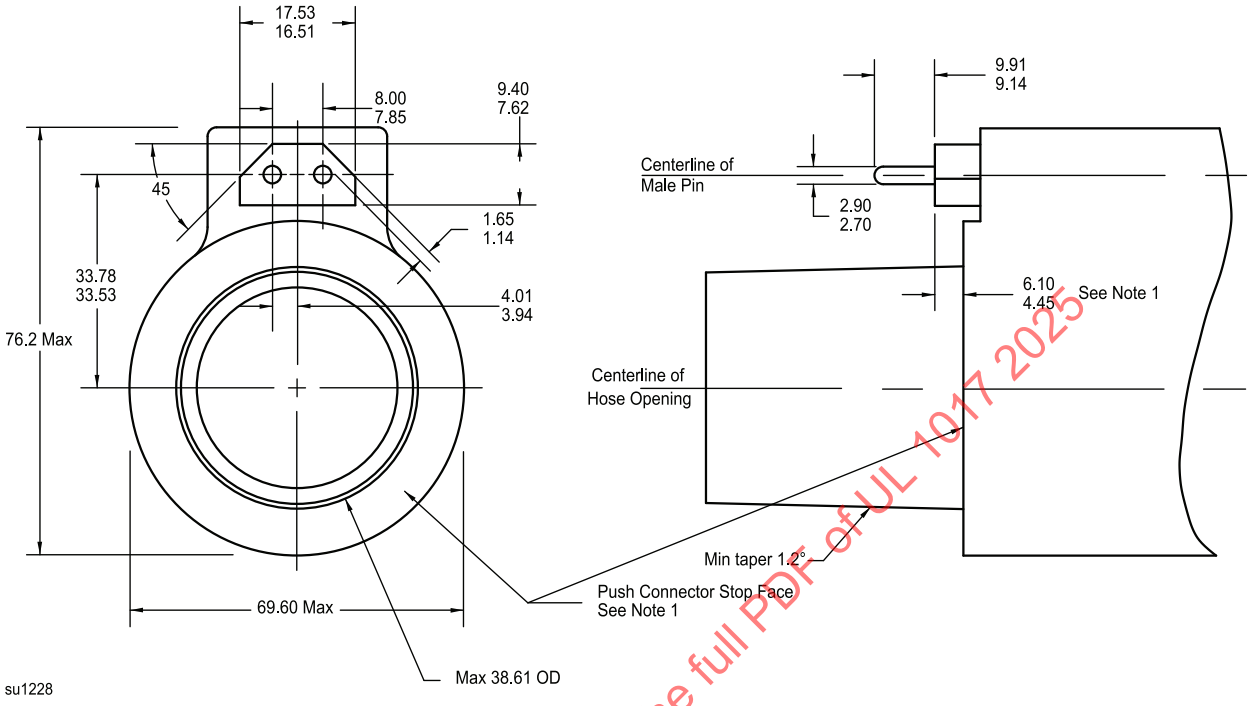


Figure 8.3

Hose End Fitting Configuration for Connection to a Type A Wall Valve



NOTES:

1. When provided with a beveled surface, the dimension is referenced from the surface of the stop face at the connector tube.

2. All dimensions in this figure are in SI units and the inches for the dimensions are:

25.4 mm = 1 in

254 mm = 10 in

8.2.6 A current-carrying hose/electrified wall-valve combination employing a configuration other than that specified in 8.2.3 and 8.2.5 shall have the hose and wall valve marked in accordance with 8.18.6, 12.5.14, and 12.5.17.

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, 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 8.17.2(b) shall have the protector located in the ungrounded current carrying conductor.

8.3 Tests – General

8.3.1 Unless otherwise specified, each sample that is subjected to the tests described in 8.4 – 8.17 shall be of the length intended for normal use.

8.4 Electric strength 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 electric strength test, 5.11 when tested in accordance with 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, 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. However, the external portion of the vacuum cleaner connector end may be tested using the conductive shot specified in 8.4.2.

8.4.4 After preparation as described in 8.4.2 or 8.4.3, the potential shall be applied between live conductors of opposite polarity, and between live 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 live 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 8.5.2, shall not be more than 0.5 MIU.

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 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, 5.3, and leakage-current after humidity conditioning, 5.4.

8.6 Oven conditioning test

8.6.1 After being conditioned as described in 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 electric strength test specified in 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 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 8.7.2, unless:

a) It is determined in the end-use application that a greater voltage drop does not have an adverse effect on the motorized nozzle connected to the hose, or

b) The current-carrying hose has a minimum 22 AWG (0.33 mm^2) 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 8.8.2. During the test:

a) The temperature rise of the insulation material (see 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 5.3.

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 8.6, shall be tested as described in 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 electric strength test, 8.4. If, after the procedure described in 8.9.2, sections of the hose exhibit more deterioration than the

sections being subjected to electric strength 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 electric strength test, 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 Except as specified in 8.10.2 a current-carrying hose shall be tested as described in 8.10.3 – 8.10.6. 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 The limited overcurrent test is not required on current-carrying hoses with a length equal to or greater than 3 m (10 ft) and a minimum 22 AWG (0.33 mm^2) or larger high-line-voltage conductors and a length equal to or greater than 3 m (10 ft) shall be if it is provided with a 7 A fuse rated no more than 7 A in the live ungrounded conductor.

8.10.3 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.

8.10.4 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 mm^2) 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.

8.10.5 A 76-mm (3-in) long, 99.9 % silver, 0.53-mm (0.02-in) diameter wire employed as described in 8.10.6, 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.

8.10.6 The silver wire mentioned in 8.10.3 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 mm^2) 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 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 electric strength test, 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, 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 electric strength potential shall then be applied between:

a) Each live conductor;

b) The live conductors and the steel plates; and

c) The live conductors and any noncurrent-carrying metal provided.

8.12 Thermal shock test

8.12.1 After being conditioned as described in 8.12.3, a current-carrying hose shall comply with the electric strength test in 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, 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 8.12.3.

8.12.3 Each sample shall be bent to form the shape shown in Figure 8.4, 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 8.5, at a rate of one flex per second. To complete a cycle of conditioning, the sample shall be returned to room temperature.

Figure 8.4

Hose Position During Conditioning

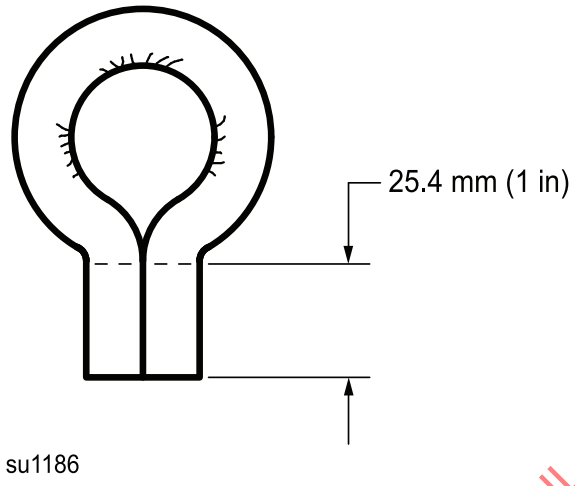
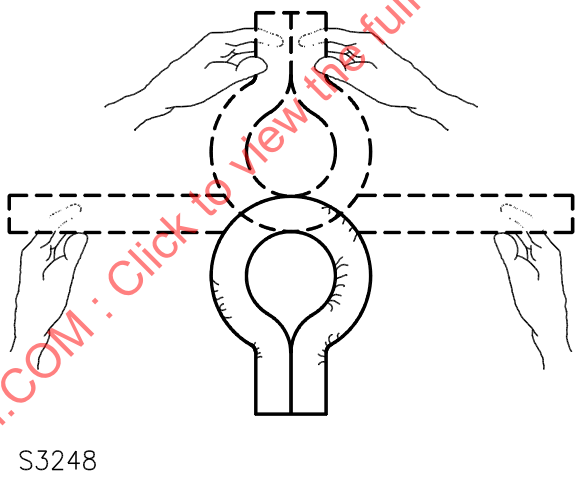


Figure 8.5

Flex Cycle



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, 8.6, shall be tested as described in 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 electric strength test, 8.4;

c) The end fitting shall not separate from the hose; and

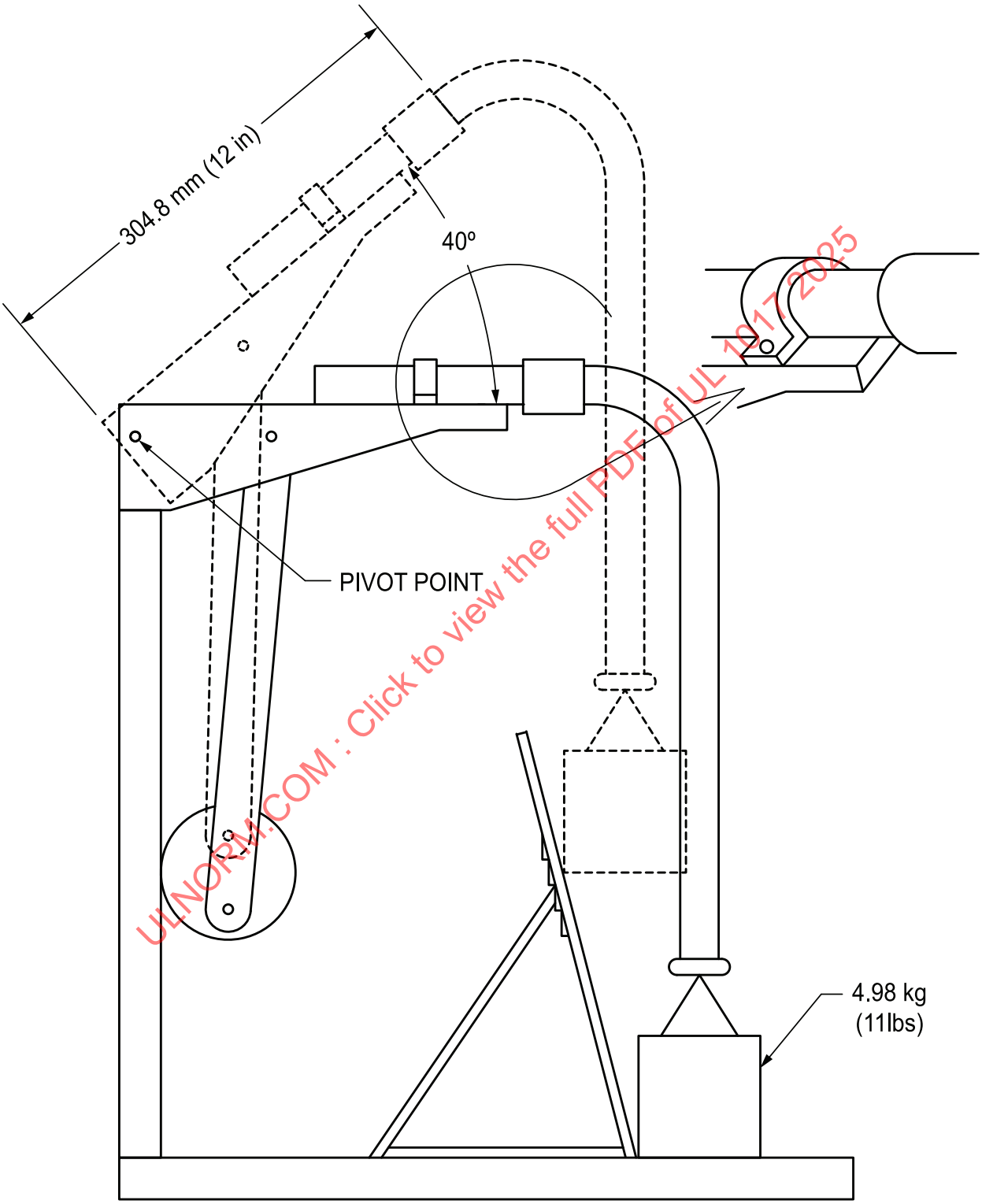
d) No sample shall have an increase of more than 10 % in electrical resistance of the hose assembly.

8.13.1.2 The test described in 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 8.6. 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.

Figure 8.6

Vertical Reciprocating Test Apparatus



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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, 8.6, shall be tested as described in 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 electric strength test, 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 ±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 8.7. The hose shall be placed over a pulley, illustrated in Figure 8.8. 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 lb ±1 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.

Figure 8.7

Horizontal Reciprocating Test Apparatus

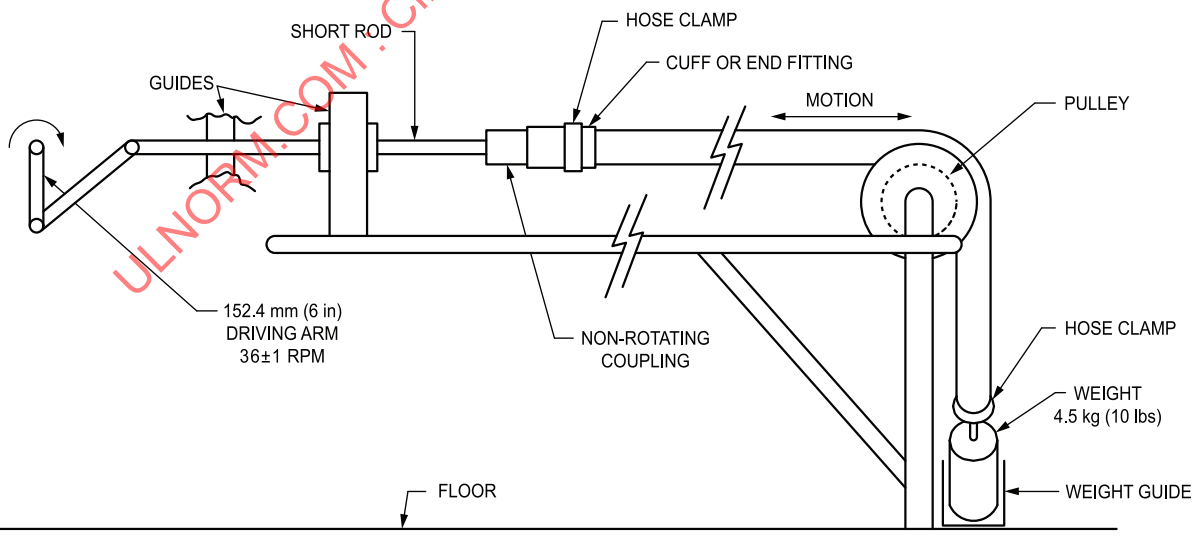
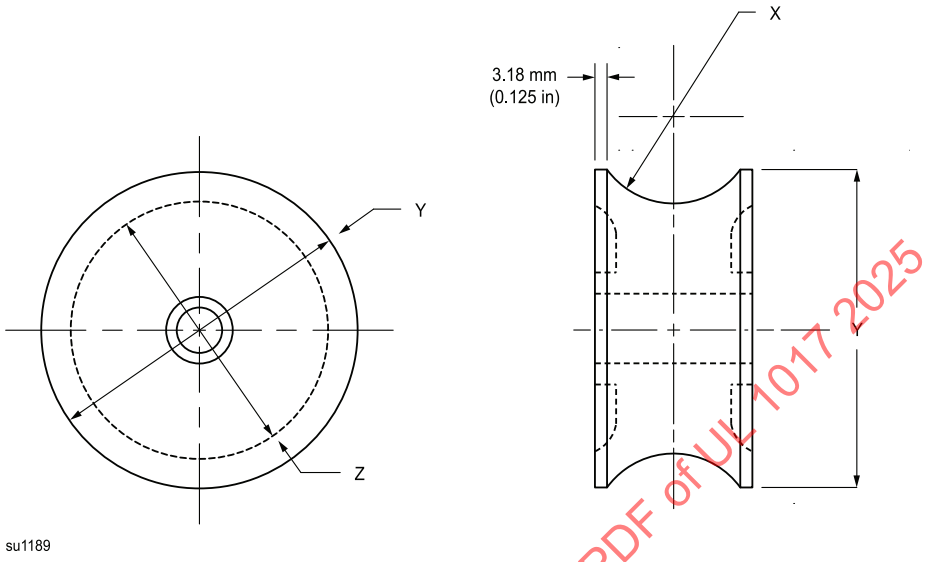


Figure 8.8

Pulley Dimensions



X = The maximum diameter of the hose +6.4 mm (1/4 in)

Y = Two times the minimum diameter of the hose plus 95.3 mm (3.75 in)

Z = Root diameter of 95.3 mm (3.75 in)

8.14 Abrasion test

8.14.1 General

8.14.1.1 A current-carrying hose shall be tested as described in 8.14.2 and 8.14.3 without exposing a live part, as determined by visual examination and by compliance, after testing, with the electric strength test, 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 8.14.2.2 shall be used for the electric strength 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, 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 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 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 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 electric strength 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, 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 m^3 (50 ft^3) 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 Section 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 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 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 electric strength test specified in 8.4.3, and the thermal-shock test, 8.12.

8.16 Endurance test

8.16.1 The attachment plug described in 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 live 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 electric strength 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 8.17.2.

8.17.2 The ground path mentioned in 8.17.1 shall carry for 2 min a 60 Hz current as specified in (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 8.10, having the grounding and one live 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 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 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 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. __."

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 and Consolidated Regulations of Canada, CRC C.1370.

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 comply with the Ultraviolet Light Exposure Test specified in CSA C22.2 No. 0.17 and UL 746C.

9.2.2 With reference to 9.2.1 and CSA 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 Unless the equipment is exclusively identified for use with lamps rated "Exempt Risk Group" by IESNA RP-27.1, equipment shall be investigated for emission of ultraviolet radiation in accordance with the ultraviolet irradiance test, 9.4.1. Equipment that produces less than 0.1 μW/cm^2 is not considered to present a risk of overexposure to ultraviolet radiation.

9.3.1.2 Equipment that emits more than 0.1 μW/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 9.3.1.7.

9.3.1.3 Equipment that emits more than 0.1 μW/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 9.5 and 9.6 for the required markings and instructions.

9.3.1.4 Equipment emitting radiation above 0.1 μW/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 9.5.3.

9.3.1.5 Equipment that emits more than 0.1 μW/cm^2 shall be provided with a user-actuated ON/OFF switch or control to activate and deactivate the ultraviolet function of the appliance.

9.3.1.6 Equipment that emits more than 0.1 μW/cm^2 shall be provided with a visible or audible means to signal when the equipment is energized, unless a momentary contact switch controls the ultraviolet radiation emission. If a visible indicating means is used, it shall be visible while approaching the equipment from any direction.

9.3.1.7 Interlocks or interlock systems used to minimize risk of overexposure to ultraviolet radiation shall be reliable and comply with 4.19.7.6 – 4.19.7.9 and 9.3.1.8 – 9.3.1.11.

9.3.1.8 The actuator of an interlock shall be located so that unintentional operation is unlikely and the actuator cannot be defeated with the articulated probe.

9.3.1.9 With reference to 9.3.1.7, 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 5.2.

9.3.1.10 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).

9.3.1.11 Electronic controls used as part of the interlock or interlock system shall comply with the requirements of 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 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 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 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 5.19 (5.19.2, 5.19.3, 5.19.4, 5.19.5) and 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 (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/m^3 on the full scale (or have auto ranging capability);

b) The capability to detect 4 µg/m^3 or lower concentration;

c) A precision of ±2 % from the mean value in the 0 mg/m^3 to 0.2 mg/m^3 range (i.e. 2 µg/m^3 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 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 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:

$$SER_{O3} = C_{max} k' VP / TR$$

Where:

SER_{O3} = Specific Emission Rate [µg/minute]

C_{max} = Maximum Measured Ozone Concentration [µg/ m^3]

k' = Ozone Decay Constant with Ventilation for the Test Chamber [1/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 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:

$$C_{LR} = \frac{[E \times T \times R]}{[V \times P \times (AER + (V_d \times (A/V))]}$$

Where:

C_{LR} = Maximum Ozone Concentration [µg/m^3] within a typical small room

E = Emission Rate [µg/h] = 60 × SER_{O3} [µg/min] calculated in 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 = Atmospheric Pressure [Pa] = 101,325

AER = Air Exchange Rate [1/h] = 0.2

V_d = Deposition Velocity [m/h] = 0.98

A/V = Surface Area to Volume Ratio [m^2/m^3] for the room = 2.5

9.4.2.4.3 An appliance shall not produce a concentration of ozone as calculated by 9.4.2.4.2 exceeding 107 µg O_3/m^3 (0.050 PPM O_3) by volume.

9.4.3 Glass impact

9.4.3.1 With reference to 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 ±5 °C (77 ±7.5 °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 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 IESNA RP-27.3.

9.5.3 With reference to 9.3.1.4, 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 9.5 related to minimizing the risk of user overexposure to ultraviolet radiation shall be repeated under the Important Safety Instructions specified in 12.2.

9.6.3 Except as specified by 9.3.1.3 for relamping, equipment with ultraviolet radiation levels over 0.1 $\mu W/cm^2$ 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.

9.7 Appliances generating radiated energy other than ultraviolet

9.7.1 Appliances having a laser generating radiated energy shall comply with Code of Federal Regulations, CFR 21, Part 1040, Chapter 1, Subchapter J in addition to Consolidated Regulations of Canada, CRC C.1370.

9.7.2 Appliances having light sources for illumination purposes shall comply with 6.3 of UL 62841-1 / CSA C22.2 No. 62841-1. This requirement does not apply to light sources for user indication purposes.

10 Manufacturing and Production Tests

10.1 Electric strength test

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 10.1.

Table 10.1
Production Line Test Conditions

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 handheld	2500	60	3000	1

[a] V is rated voltage of the appliance.

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. 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. 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 electric strength potential, the test mentioned in 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 10.1. 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 10.1.6 – 10.1.8, may be used if found to accomplish the intended factory control.

10.1.10 Except as specified in 10.1.11 and 10.1.12, 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.

10.1.11 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.

10.1.12 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 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 fixed 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."

11.1.2 The manufacturer's identification specified in 11.1.3(a) may be in a traceable code if the appliance is identified by the brand or trademark owned by a private labeler.

11.1.3 The date of manufacture specified in 11.1.3(c) 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.

11.1.4 The electrical rating specified in 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.

11.1.5 The international symbol for the nature of supply ⎓ may be used instead of "DC" if the significance of this symbol is explained in the instructions packaged with the product. When used, the symbol shall be placed next to the marking for rated voltage.

11.1.6 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 11.1.4 to separately identify the input with and without the attachment. See 11.1.7.

11.1.7 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.

11.1.8 The following shall be marked with a distinctive catalog number or the equivalent if packaged and marketed separately from the basic appliance:

a) An electrical attachment,

b) A non-electrical attachment with air-driven parts or intended for wet pick-up applications on a dry pick-up vacuum cleaner, and

c) A proprietary fluid. See 12.7 as it relates to cleaning fluid designations.

11.1.9 An appliance provided with one or more general-use receptacles shall be marked in accordance with 11.1.4 to separately identify the input with and without the receptacle rating(s). See 11.4.22.

11.1.10 A vacuum cleaner with a steam-cleaning attachment shall be marked in accordance with 11.1.4 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.

11.1.11 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 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 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 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 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 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 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 Section 6.

11.3.7 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.

11.3.8 If a specific spacing is necessary between a central vacuum cleaner and the surfaces of the test alcove described in 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 5.3, 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)."

11.3.9 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 5.3, 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 12.5.5.

11.3.10 Unless included in the installation instructions as specified in 12.5.6, an appliance for which it is necessary that exhaust air be vented for proper operation 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.

11.3.11 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.

11.3.12 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 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 4.5.1.6, construction type; and

c) The importance of using such a cord; see 12.2.7(k).

11.3.13 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.

11.3.14 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.)

11.3.15 For appliances with a GFCI, 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."

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 an appliance has an accessible hazardous moving part 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 I and O 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 11.1 shall be provided with a permanent marking containing the applicable warning. The wording of the marking shall be as stated in Table 11.1 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.

Table 11.1
Warning Markings

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. 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. 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.
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 only 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.

11.4.9 The warning marking required by 11.4.7 and Table 11.1 may be provided on the non-detachable power supply cord in the form of a cord tag; see Cord tags, 11.5.

11.4.10 With reference to the requirement in 11.4.7 and Table 11.1, 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 11.4.7 and Table 11.1 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 11.1 and is in smaller print.

11.4.12 If the appliance cannot be used without a hose, the marking required in 11.4.7 and Table 11.1 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 11.4.7 and Table 11.1 shall also be marked on the hose in accordance with 11.4.8.

11.4.14 A central vacuum cleaner not intended for wet pick-up shall be marked in accordance with Item 6 of Table 11.1. 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 fixed 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 12.5.9.

11.4.16 A part of an enclosure as described in 4.19.3.4 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 An electronically controlled motor-driven brush as described in Table 4.8 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 fixed 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 11.2. 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.

Table 11.2
Outlet-Box Marking

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)

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 An appliance provided with a general-use receptacle or receptacles in accordance with 4.14.2 shall be marked with the word "CAUTION" and the following or the equivalent in (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.

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 4.5.1.14, 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 4.5.1.14, the appliance shall be provided with the following correlation cautionary marking or equivalent "WARNING: For Use Only With + Part No. ++ Supply Cord."

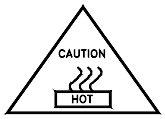
+ Replace with the vacuum cleaner manufacturer's name.

++ 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 4.15 (see 4.19.4.2), 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.



SM218

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 or burns or scalding, do not open the water fill cap when using the steam cleaner."

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 cleaner."

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 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 With reference to 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)."

11.4.30 A self-restoring guard on a motorized nozzle as described in 4.19.3.8 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."

11.4.31 A vacuum cleaner intended for marine vessel installation not shown to comply with the requirements of the Vibration Test, 5.19.6, or Shock Test, 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."

11.4.32 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."

11.4.33 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".

11.4.34 An ash vacuum cleaner as described in 3.9 shall be marked with the following or equivalent: "WARNING – To reduce the risk of fire or heat damage – Do not place the dust container on flammable or polymeric surfaces, including carpeting and vinyl tile. The dust container must be cleaned and emptied before and after each use.

11.5 Cord tags

11.5.1 The cord tag described in 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 UL 969A or 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 11.5.4, and then subjected to the test described in 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.