

6.15 Resistance to impact test

6.15.1 The appliance shall withstand the applicable impact tests specified in Clause 5.19 without making accessible to contact noncurrent-carrying metal parts that are insulated from live parts by basic insulation only, and basic insulation. The appliance shall comply with the dielectric voltage-withstand test in Clause 6.13 after being subjected to the impact test.

6.16 Abnormal operation test

6.16.1 Abnormal operation as specified in Clause 5.21.7 shall not affect the insulation to the extent that it does not comply with Clause 6.16.2 or that it exposes live parts. The tests specified in abnormal operation, Clause 5.21.7, shall be conducted on all double insulated appliances regardless of whether they employ thermoplastic or metal enclosures.

6.16.2 Following abnormal operation specified in Clause 6.16.1, the appliance shall be given time to cool to room temperature and shall withstand for 1 min without breakdown the application, between live parts and accessible noncurrent-carrying metal parts, or the foil described in note b of Table 14 and Figure 14, of the potential specified in Table 15.

6.17 Overload test on motors

6.17.1 General

6.17.1.1 Operation of a motor under conditions of extreme overload shall not affect the appliance insulation to the extent that the insulation does not comply with Clause 6.17.4.3 or that live parts are exposed.

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

6.17.2 Vacuum cleaners and blower cleaners

6.17.2.1 Each of three samples of the motor shall be subjected to operation at rated load for 1 h. Immediately following this, the load shall be increased in steps of 10% of the rated current for each of four successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min each as prove necessary to achieve breakdown of the basic insulation.

6.17.3 Household use floor finishing machines

6.17.3.1 Each of three samples of the complete product shall be subjected to operation at no load for 1/2 h, immediately followed by operation at full load for 1/2 h. Immediately following this, the load shall be increased in steps of 10% of the rated current for each of four successive 1-h periods, followed by two 1/2-h periods, followed by eight 1/4-h periods, followed by such additional periods of 5 min each as prove necessary to produce malfunction or breakdown of the basic insulation.

6.17.4 Test conditions

6.17.4.1 With reference to Clauses 6.17.2.1 and 6.17.3.1, breakdown of the basic insulation shall be considered to have occurred when flame appears or the winding burns open. If flame appears, the overload operation shall be terminated, and the flames extinguished.

6.17.4.2 During the running-overload operation described in Clause 6.17.2.1 or 6.17.3.1, any protective device provided with the motor shall be short-circuited, and the branch-circuit protection shall be of high enough capacity to withstand the test currents without opening the circuit. The objective of the test shall determine the integrity of the motor insulation and not the effectiveness of a protective device.

6.17.4.3 Following the operation described in Clause 6.17.2.1 or 6.17.3.1, the motor shall be given time to cool to room temperature and the appliance shall withstand for 1 min, without breakdown, the application of a 60-Hz potential of 1000 V plus twice the rated voltage between:

- a) Live parts and accessible noncurrent-carrying metal parts or the foil as mentioned in item 2 of Table 15 and Figure 14; and
- b) All inaccessible noncurrent-carrying metal parts and accessible noncurrent-carrying metal parts or the foil as mentioned in item 2 of Table 15 and Figure 14.

6.18 Investigation of armature employing reinforced insulation

6.18.1 If a motor construction includes reinforced armature insulation as mentioned in Clause 6.4.5.1(c), each of three samples of the armature, after each of three conditioning procedures described in Clauses 6.18.2 – 6.18.4, shall withstand for 1 min, without breakdown, the application of a 60 Hz sinusoidal potential of 1000 V plus twice the rated voltage between the armature winding and the noncurrent-carrying metal that is separated from live parts by reinforced insulation.

6.18.2 The three samples mentioned in Clause 6.18.1 shall first be conditioned in an oven for 500 h at a temperature of 120°C (248°F) for a Class A system, 140°C (284°F) for a Class B system or 20°C (68°F) higher than the temperature rating of the insulation, if other than Class A or Class B.

6.18.3 One armature sample shall then be caused to carry the locked rotor current of the motor, another shall be caused to carry half of such locked rotor current, and the third shall be caused to carry one fourth of that locked rotor current. The specified current shall flow in each sample for 4 h unless breakdown of the basic insulation, as defined in Clause 6.17.4.1, occurs before the end of that interval. If breakdown of the basic insulation of a given sample does not occur before the end of the 4-h period, the test shall be continued as long as is necessary to accomplish that result, with the current during each additional hour being increased by 50% of the initial value.

6.18.4 Each sample shall then be rotated at its normal no-load speed for 1 min by any convenient external means.

6.19 Resistance to moisture test

6.19.1 As a result of the applicable tests mentioned in resistance to moisture, Clause 5.12, the appliance shall:

- a) Comply with the leakage-current test, Clause 6.12; and
- b) Withstand for 1 min, without breakdown, the application of a 60 Hz essentially sinusoidal potential of 2000 V plus twice the rated voltage of the appliance between live parts and accessible noncurrent-carrying metal parts, or the foil mentioned in note b to Table 14 and Figure 14.

6.20 Manufacturing and production tests

6.20.1 Production line dielectric voltage-withstand test

6.20.1.1 Each appliance marked as double insulated shall withstand for one second without electrical breakdown, as a routine production-line test, the application of the potentials indicated in Table 16 in accordance with the test method described in dielectric voltage-withstand, Clause 10.1.

7 Rechargeable Battery-Powered Appliances

7.1 Products covered by this clause of the standard that are powered by rechargeable batteries either solely or as an alternative or in conjunction with other sources shall meet the requirements of UL 2595 / CSA C22.2 No. 0.23, with the conditions and specifications as required by Appendix D of that standard as indicated in Clauses 7.2 – 7.16 below.

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

- a) Clauses 6 (Double Insulation), 8 (Current-carrying hoses and accessory electrified wall valves), and 10 (Manufacturing and Production Tests) do not apply in their entirety.
- b) The Clauses specified in Table 32 do not apply.
- c) The portions of Clause 5.12 that require the outcome of conditioning or testing to comply with dielectric voltage withstand and/or leakage current, and the wetting of any electrical components, shall instead consider increased risk of injury to persons, fire or shock for those areas where the voltages are in excess of the hazardous voltage; see Section 8 of UL 2595. In the application of Section 8 of UL 2595 / CSA C22.2 No. 0.23, a part that is wetted during the testing of Clause 5.12 is considered an accessible part.
- d) For Clause 5.12.2.3, the test is conducted as specified in Section 11.1 of UL 2595 / CSA C22.2 No. 0.23, rather than measuring the motor winding temperatures.
- e) Clause 5.21.10 is applied, but only in reference to the external temperatures recorded during the heating test of UL 2595 / CSA C22.2 No. 0.23.

f) The Clauses referenced in (a) – (e) above would apply to those products also powered from mains or other non-isolated sources to the extent that requirement would apply to the risk of electric shock in the area of the product containing such a source.

g) The testing of Clause 5.19 applies to the appliance, but the acceptance/compliance criteria of the mechanical strength test of UL 2595 / CSA C22.2 No. 0.23 shall be applied.

h) For Clauses 11.4.7, 11.4.18, 11.4.19, 12.2, and Table 18, the marking or instruction requirements that pertain to the risk of electric shock only apply to products operating at hazardous voltages. Items related to the risk of fire or explosion (e.g., items 14, 15, and 16 of Table 18) shall apply as indicated.

i) For Clauses 11.4.14 and 11.4.15, the statement “Unplug Before Cleaning or Servicing” shall be replaced with “Disconnect Battery Pack Before Cleaning or Servicing”, or the equivalent.

7.3 With respect to Indent B of Appendix D of UL 2595 / CSA C22.2 No. 0.23, users are not considered to be wet during the use of these products except for wet pick up and extractor type appliances.

7.4 With respect to Indent C of Appendix D of UL 2595 / CSA C22.2 No. 0.23, LT specification is required for batteries for products not marked intended for indoor use; see Table 18 of this end product standard, and ELT: –35°C specification for products not marked “Use Indoors” or “Store Indoors”.

7.5 With respect to Indent D of Appendix D of UL 2595 / CSA C22.2 No. 0.23, during the heating test, portable vacuum cleaners shall be operated without detachable hoses and attachments and with no additional restriction on the intake of air.

7.6 With respect to Indent E of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the temperature limits listed in Table 9.1 of UL 2595 are considered suitable.

7.7 With respect to Indent F of Appendix D of UL 2595 / CSA C22.2 No. 0.23, during the abnormal tests of the of Appendix D of UL 2595, the appliance shall be operated with the intake ports uncovered and with no additional mechanical load for those tests where applicable.

7.8 With respect to Indent G of Appendix D of UL 2595 / CSA C22.2 No. 0.23, additional or alternative safety-critical functions (SCFs) are identified in Table 30 of this end product standard.

7.9 With respect to Indent H of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the impact surface may be conducted on hardwood or concrete.

7.10 With respect to Indent I of Appendix D of UL 2595 / CSA C22.2 No. 0.23, products covered by this end-product standard are not required to have this special switching arrangement.

7.11 With respect to Indent J of Appendix D of UL 2595 / CSA C22.2 No. 0.23, battery-operated appliances that can also be operated or charged by mains or a non-isolated sources as described in UL 2595, shall also meet the requirements of this end-product standard that apply to the risk of electric shock. For these types of appliances, the exempted requirements specified in Clause 7.2(b) of this end-product standard might be applicable.

7.12 The requirements in Clauses 7.13 – 7.17 of this end-product standard additionally apply to automatic battery-powered vacuum cleaners (e.g., robot vacuums and their docking stations).

7.13 In the application of UL 2595 / CSA C22.2 No. 0.23, Section 6.7, an automatic battery-powered vacuum cleaner shall be marked "For use only with ____ docking station," or the equivalent. The docking station may be identified by a catalog number, series identification, or the equivalent. Alternatively, the statement "See Instruction Manual for Additional Docking Stations," or the equivalent, may be employed in addition to at least one docking station referenced by catalog number.

7.14 With respect to Indent A of Appendix D of UL 2595 / CSA C22.2 No. 0.23, in the application of Clauses 12.2.6 and 12.2.7 of this end-product standard, an automatic battery-powered vacuum cleaner shall also be provided with the following cautionary instructions or the equivalent regarding proper room preparation before using the appliance:

- a) Place the cords from other appliances out of the area to be cleaned.
- b) Do not operate the vacuum in a room where an infant or child is sleeping.
- c) Do not operate the vacuum in an area where there are lit candles or fragile objects on the floor to be cleaned.
- d) Do not operate the vacuum in a room that has lit candles on furniture that the vacuum may accidentally hit or bump into.
- e) Do not allow children to sit on the vacuum.
- f) Do not use the vacuum on a wet surface.

7.15 With respect to Indent D of Appendix D of UL 2595 / CSA C22.2 No. 0.23, during the heating test, automatic battery-powered vacuum cleaners shall be operated on the test carpet described in Clause 5.2.1.2 of this end-product standard. A border or frame measuring 1.5 m by 1.5 m (5-ft by 5-ft) shall be used on the carpet to limit the area of operation. The air inlet shall be unobstructed.

7.16 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 vacuum cleaners are in Table 31 of this end-product standard.

7.17 With respect to Indent H of Appendix D of UL 2595 / CSA C22.2 No. 0.23, the robot vacuum part of an automatic rechargeable battery-powered vacuum cleaner shall be subjected to an evenly distributed load of 60 kg (130-lbs) placed on top of the vacuum for a period of one minute. This test shall be conducted on three samples of the vacuum. As a result of the testing, no short circuit shall occur, and there shall not be any condition that would increase the risk of fire or personal injury resulting from operation of the appliance.

8 Current-carrying hoses and accessory electrified wall valves

8.1 Scope

8.1.1 These requirements cover:

- a) Current-carrying hoses for use with vacuum cleaner/motorized nozzle combination appliances intended for household, dry pick-up, indoor use;

- b) Current-carrying hoses for use with motorized nozzles intended for use with central vacuum cleaning systems intended for household, dry pick-up, indoor use;
- c) Wet pick-up current-carrying hoses for use with household, indoor use carpet cleaning equipment;
- d) Grounded current-carrying hoses for use with motorized nozzles intended for household indoor use; and
- e) Electrified wall valves for connection of current-carrying hose/motorized nozzle combinations for central vacuum cleaning systems intended for household use.

8.1.2 These requirements supplement those in Clauses 1 – 6 and Clause 11 of this Standard.

8.2 Construction – General

8.2.1 A current-carrying hose, as covered by these requirements, consists of individually insulated copper, copper-clad steel, or steel-reinforced copper conductors that are additionally insulated by the hose structure. The conductors may be used for structural support of the hose.

Exception: The grounding conductor need not be individually insulated if separated from current carrying conductors by minimum 0.78 mm (1/32 in) thickness of the hose structure insulation (see Clause 8.18).

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 current-carrying conductors.

8.2.3 An electrified wall valve for a central vacuum cleaning system intended for the connection of a current-carrying hose/motorized nozzle combination shall be configured as shown in Figure 21. See Clause 8.2.6. In addition, the wall-valve assembly shall comply with the applicable requirements in the following standards:

- a) C22.2 No. 18.1 and UL 514A;
- b) C22.2 No. 18.2 and UL 514C; and
- c) C22.2 No. 42.1 and UL 514D.

8.2.4 The configuration of the field wiring leads to the connector of a wall-valve assembly shall be as shown in Figure 22.

8.2.5 The end fitting of a current-carrying hose intended for connection to a central vacuum cleaner wall valve, employing direct supply connections for electrical accessories, shall be configured as shown in Figure 23. See Clause 8.2.6.

8.2.6 A current-carrying hose/electrified wall-valve combination employing a configuration other than that specified in Clauses 8.2.3 and 8.2.5 shall have the hose and wall valve marked in accordance with Clauses 8.19.6, 12.5.13, and the Exception to Clause 12.5.15.

8.2.7 All accessible noncurrent-carrying metal parts of a central vacuum cleaner's electrified wall valve assembly (outlet assembly) that are likely to be energized shall be connected to the equipment grounding conductor or equipment grounding terminal of the valve assembly. Parts that are not considered likely to be energized are metal screws or rivets in polymeric enclosures or faceplates, external metal springs used on a self-closing polymeric cover, and the like. Electrified wall valves connected to an extra-low voltage circuit are excluded from this requirement.

8.2.8 An attachment plug used on a current-carrying hose end fitting in which the orientation of the parallel blades can be rotated by the user, shall be provided with the means to prevent unintentional rotation and shall be subjected to the Endurance Test, Clause 8.16.

8.2.9 A grounded type current-carrying hose optionally protected by overcurrent devices provided in the appliance for purpose of the test specified in Clause 8.18.2(b) shall have the protector located in the ungrounded current carrying conductor.

8.2.10 Current-carrying hoses with a minimum 22 AWG (0.33 mm²) high-voltage conductor and a length equal to or greater than 3 m (10 ft) shall be provided with a 7 A fuse in the live conductor.

Exception: The Limited overcurrent test of Clause 8.10 may be performed in lieu of adding the fuse.

8.3 Tests – General

8.3.1 Unless otherwise specified, each sample that is subjected to the tests described in Clauses 8.4 – 8.16 shall be of the length intended for normal use.

8.4 Dielectric voltage-withstand test

8.4.1 A current-carrying hose shall withstand without breakdown for 1 min the application of a 60 Hz essentially sinusoidal potential as described in the dielectric voltage-withstand test, Clause 5.11 when tested in accordance with Clauses 8.4.2 or 8.4.3, and 8.4.4.

8.4.2 A sample of a dry pick-up hose, including the complete end fittings, shall be tested in the as-received condition. The sample shall be suspended in a vertical position with 0.61 m (2 ft) of the hose and the complete end fitting placed into a container. The container and the inside of the hose section that is within the container shall be filled with No. 7-1/2 conductive shot, except that, if agreeable to those concerned, smaller shot may be used. For the purpose of this test, an uninsulated live part, such as a pin terminal, used to facilitate a user separable connection shall be insulated. Additionally, any opening in a hose end fitting that complies with accessibility to live parts, Clause 4.2.5, may be sealed.

8.4.3 A sample of a wet pick-up current-carrying hose shall be tested while immersed in a solution consisting of 0.5 g of sodium chloride per liter of distilled water. All the air shall be displaced by the solution from the interior of the hose during the immersion.

Exception: The external portion of the vacuum cleaner connector end may be tested using the conductive shot specified in Clause 8.4.2.

8.4.4 After preparation as described in Clause 8.4.2 or 8.4.3, the potential shall be applied between current-carrying conductors of opposite polarity, and between current-carrying conductors and the conductive shot or solution. The test shall be conducted on each end of the sample if different end fittings are employed.

8.4.5 For a current-carrying hose with integral grounding conductor, the potential shall also be applied between each current-carrying conductor and the grounding conductor.

8.5 Leakage-current test

8.5.1 The leakage current of a current-carrying hose, when tested as described in Clause 8.5.2, shall not be more than 0.5 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 Clause 8.4.2 or 8.4.3, as applicable. The leakage current shall be measured from the conductive shot for a dry pick-up hose, and from the solution for a wet pick-up hose. The test method shall be as specified for leakage-current, Clause 5.3, and leakage-current after humidity conditioning, Clause 5.4.

8.6 Oven conditioning test

8.6.1 After being conditioned as described in Clause 8.6.2, the insulation of a current-carrying hose shall not show excessive deterioration – for example, cracking, flaking, or softening – and shall comply with the dielectric voltage-withstand test specified in Clause 8.4.1.

8.6.2 Three samples of the complete current-carrying hose assembly shall be conditioned for 7 h in an air-circulating oven at 70°C (158°F). After being removed from the oven, the samples shall be examined for deterioration. For the purpose of this test, discoloration of the hose material shall not be considered deterioration.

8.6.3 Additional samples to be conditioned as described in Clause 8.6.2 prior to further testing shall remain at normal room temperature for a minimum of 24 h after removal from the oven before such tests are conducted.

8.7 Voltage drop test

8.7.1 The voltage drop across a current-carrying hose shall not exceed 6% of the rated voltage when the hose is tested as described in Clause 8.7.2.

Exception No. 1: The voltage drop may exceed 6% if it is determined in the end-use application that such a drop does not have an adverse effect on the motorized nozzle connected to the hose.

Exception No. 2: The test is not carried out on current-carrying hoses having a minimum 22 AWG (0.33 mm²) conductor size.

8.7.2 The hose shall be connected to a 60 Hz supply circuit that causes it to carry rated current. This condition shall continue until temperatures stabilize, at which time the maximum voltage drop across both conductors shall be measured.

8.8 Temperature test

8.8.1 A current-carrying hose shall be tested as described in Clause 8.8.2. During the test:

- a) The temperature rise of the insulation material (see Clause 8.2) shall not exceed 35°C (63°F) at any point; and
- b) No other material or component part shall exceed the temperature rises specified in Table 9.

8.8.2 The hose shall be placed on a softwood surface and shall be connected to a 60 Hz supply circuit that causes the hose to carry rated current. The test shall be continued until constant temperatures are reached. Temperatures shall be measured using thermocouples.

8.9 Overload test

8.9.1 Two samples of the hose, one in the as-received condition and one subjected to the oven conditioning specified in Clause 8.6, shall be tested as described in Clause 8.9.2. During the test, there shall be no evidence of a risk of fire and, upon completion of the test, the hose shall comply with the dielectric voltage-withstand test, Clause 8.4. If, after the procedure described in Clause 8.9.2, sections of the hose exhibit more deterioration than the sections being subjected to dielectric testing, then a 0.61-m (2-ft) long sample of the more deteriorated section or sections of the hose shall also be subjected to the dielectric voltage-withstand test, Clause 8.4.

8.9.2 The hose shall be placed on a softwood surface that is covered by a single layer of white tissue paper. It shall be connected to a circuit that causes the hose to carry rated locked-rotor current continuously for 7 h.

8.10 Limited overcurrent test

8.10.1 A current-carrying hose shall be tested as described in Clauses 8.10.2 – 8.10.5. During the test, there shall be no evidence of a risk of fire, and, upon completion of the test, there shall be no exposure of current-carrying parts.

8.10.2 Three samples of a current-carrying hose in the as-received condition shall be tested. Each sample shall be placed on a softwood surface that is covered by a single layer of white tissue paper and draped with a single layer of cheesecloth. For a hose that is less than 4.6-m (15-ft) long, the hose shall be tested in a straight configuration. For a hose that is 4.6 m (15 ft) or longer:

- a) Two-thirds of the hose at the end intended for connection to the test circuit shall be in a coiled configuration having a 0.5-m (1.6-ft) inner diameter of the coil; and
- b) One-third of the hose at the end intended for connection to the power nozzle shall be in a straight configuration.

8.10.3 The conductors at the end of the hose intended for connection to the power nozzle shall be externally connected together. The other end of the hose shall be connected in series with 18 AWG (0.82 mm²) Type SVT cord to a 120 V, 60 Hz test circuit with a power factor of 0.9 to 1.0. Without the hose in the circuit, the circuit shall have a short-circuit capacity of 200 A. The length of the cord shall be 5.5 m (18 ft) for a hose intended for use with a portable appliance, or 1.8 m (6 ft) for a hose intended to be connected directly to the source of electrical supply. The hose may be connected in parallel with a load representing a vacuum cleaner of the minimum rating intended to be used with the hose assembly.

8.10.4 A 76-mm (3-in) long, 99.9% silver, 0.53-mm (0.02-in) diameter wire employed as described in Clause 8.10.5, or the fuse provided in the appliance, shall be connected in series with the hose under test. If there is no evidence of a risk of fire, the test shall continue until the series silver wire opens at least one inch from either terminal to which it is connected, the appliance fuse opens, or for a period of 7 h, whichever occurs first.

8.10.5 The silver wire mentioned in Clause 8.10.2 shall be placed horizontally along the center line of a box with approximate inside dimensions of 89-mm (3-1/2-in) long, 45-mm (1-3/4-in) wide, and 76-mm (3-in) high. Two wiring terminals shall be spaced 76-mm (3-in) apart inside the box, and one end of the silver wire shall be connected to each terminal so that the wire measures 3 in from terminal to terminal. The silver wire shall be connected to the hose under test with 12 AWG (3.3 mm²) copper wire connected through wireways (small openings or holes) in the sides of the box.

8.11 Crushing test

8.11.1 A current-carrying hose shall be subjected to a crushing force of 2,224 N (500 lb) as described in Clause 8.11.2. While the force is maintained at 2,224 N (500 lb), the hose shall withstand for 1 min without breakdown the application of a 60 Hz essentially sinusoidal potential as specified in the dielectric voltage-withstand test, Clause 5.11. Following the test, there shall be no exposure of any uninsulated live parts.

8.11.2 A current-carrying hose in the as-received condition and one that has been conditioned as described in oven conditioning test, Clause 8.6, shall be tested. Each sample shall not be less than 203-mm (8-in) long. The hose shall be:

- a) Placed between two 102- by 102-mm (4- by 4-in), 12.7-mm (1/2-in) thick steel plates with a 1.6-mm (1/16-in) radius at the edges; and
- b) Positioned so that its major axis is perpendicular to two opposite edges of the steel plates.

8.11.3 The sample and the plates shall then be placed in a testing machine that will decrease the distance between the plates at a rate of not more than 12.7 mm/min (1/2 in/min). The crushing force shall be applied until a force of 2224 N (500 lbs) is reached. The dielectric potential shall then be applied between:

- a) Each current-carrying conductor;
- b) The current-carrying conductors and the steel plates; and
- c) The current-carrying conductors and any noncurrent-carrying metal provided.