19.16 Pumps

19.16.1 Pumps shall be evaluated to this Standard or comply with CSA-C22.2 No. 108 and UL 778.

19.16.2 Polymeric parts of pumps subjected to wash water, detergent, or rinse agent shall also be subjected to the immersion test in Clause 26.3.

19.17 Insulating devices

19.17.1 The requirements for insulating devices, such as wire positioning devices or insulating bushings, are not specified unless the insulating device is required to comply with this Standard. In such cases, the insulating device shall comply with the applicable requirements of this Standard or shall be evaluated in accordance with the following standards, as applicable:

a) CSA C22.2 No. 18.5 and UL 1565 for wire positioning devices; or

b) UL 635 for insulating bushings.

19.17.2 Tests specified in this Standard (eg, strain relief test) shall be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

19.18 Adhesives used to secure parts

19.18.1 An adhesive relied upon to reduce the risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in UL 746C.

19.18.2 The requirement in Clause 19.18.1 also applies to an adhesive used to secure a conductive part, that if loosened or dislodged:

a) energizes an accessible dead metal part;

b) makes a live part accessible;

c) reduces spacings below the minimum acceptable values; or

d) short-circuits live parts.

19.19 Transformers and power supplies

19.19.1 Transformers located in a low-voltage circuit that does not involve a risk of fire or personal injury need not comply with the standards referenced in Clauses 19.19.2 – 19.19.5.

19.19.2 Class 2 transformers shall comply with CSA C22.2 No. 66.3 and UL 5085-3.

19.19.3 General purpose transformers shall comply with:

a) CSA C22.2 No. 66.2; and

b) UL 5085-2.

19.19.4 Class 2 power supplies shall comply with:

a) CSA-C22.2 No. 223 and UL 1310; or

b) for power supplies with non-linear transformers, CSA C22.2 No. 60950-1 and UL 60950-1.

19.19.5 Power supplies other than Class 2 power supplies shall comply with:

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

b) for power supplies with non-linear transformers, CSA C22.2 No. 60950-1 and UL 60950-1.

19.20 Button or coin cell batteries of lithium technologies

19.20.1 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more coin cell batteries of lithium technologies, 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) maximum with a diameter greater than its height; and

b) the appliance is intended for household use.

20 Supply connection and external flexible cords

20.1 General

20.1.1 An appliance shall be provided with wiring terminals or leads for the connection of conductors that will be connected in the field and means for connection of a wiring system.

Note: An appliance other than a wall-insert type may be provided with a flexible cord and an attachment plug for connection to the supply circuit.

20.2 Permanently connected appliances

20.2.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in the Canadian Electrical Code, Part 1 (CE Code) for Wiring Methods and the National Electrical Code (NEC) for Wiring Methods and Materials, that comply with the relevant CSA and UL Standards, and Clause 19.1, are considered to fulfill the requirements of this Standard.

Note: Examples of relevant 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, and CSA C22.2 No. 42.1 and UL 514D.

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

Note: The appliance may be moved to examine these connections.

20.2.3 The requirement in Clause 20.2.2 necessitates that the terminal box of a wall-insert appliance be located so that it will be accessible without the necessity of moving the appliance after installation, unless the appliance is provided with not less than 1.5 m of either:

a) flexible metallic conduit with conductors; or

b) armored cable;

to extend the point of supply to an accessible location.

Note: The top or front of the appliance may serve as the inspection cover, provided that the fastening means for the cover is apparent, or indicated, and that the cover can be moved and replaced without damage to the cover or fastening means.

20.2.4 An outlet box, terminal box, wiring compartment, or the like in which connections to the supply circuit will be made in the field shall be free from any sharp edges, including screw threads, a burr, a fin, a moving part, or the like, that could damage the insulation on a conductor.

20.2.5 If it is intended that supply connections be made to the motor of an appliance, the terminal compartment on the motor shall comply with the requirements for terminal compartments in CSA- C22.2 No. 100 and UL 1004-1.

20.2.6 Conduit connection shall not be made to covers giving access to supply terminals. Component parts shall not be mounted on removable covers giving access to supply connections.

20.2.7 An opening in a wiring compartment for the connection to the power supply in the field, whether in the form of a knockout or an open hole, shall:

a) have the minimum width of flat surface surrounding the opening as specified in Table 4; or

b) be acceptable when the test gauge for flat surfaces surrounding a knockout is applied as specified in CSA C22.2 No. 0.5 and UL 514A.

20.2.8 A knockout shall remain in place when a force of 44.5 N is applied at right angles to the knockout by means of a mandrel with a 6.4 mm diameter flat end. The mandrel shall be applied at the point most likely to result in movement of the knockout.

20.2.9 The removal of a knockout shall not result in deformation that would affect the attachment of a strain relief or fitting, or result in reduction of electrical spacings below the minimum acceptable values.

20.2.10 At a point where the power-supply conductors enter the enclosure, sheet metal shall not be less than 0.81 mm thick if uncoated steel, not less than 0.86 mm if galvanized steel, not less than 1.09 mm if copper or brass, and not less than 1.12 mm if aluminum.

20.3 Cord-connected appliances

20.3.1 A power-supply cord shall comply with CSA C22.2 No. 21 and UL 817.

20.3.2 Flexible cords and cables shall comply with CSA C22.2 No. 49 and UL 62. Flexible cords or cables are considered to fulfill this requirement when preassembled into a power-supply cord complying with Clause 20.3.1.

20.3.3 Attachment plugs and appliance couplers shall comply with CSA C22.2 No. 42 and UL 498. Attachment plugs and appliance couplers are considered to fulfill this requirement when preassembled into a power-supply cord complying with Clause 20.3.1.

20.3.4 The flexible cord shall have an ampacity not less than the current rating of the appliance.

20.3.5 An attachment plug shall have an ampere rating not less than 125% of the rated current of the appliance, and shall have a voltage rating not less than the rated voltage of the appliance, except as stated in Clause 20.3.6.

20.3.6 A stationary product marked in accordance with Clause 5.1.2.12 shall employ an attachment plug rated at no less than the current rating of the appliance or the input current under normal load conditions in Clause 8, whichever is greater.

20.3.7 Flexible cord shall be type HSJ, HSJO, SJ, SJO, SJT, SJTO, S, SO, ST, STO, HSJOO, SJOO, SJTOO, SOO, or STOO. Type SP-3 or SPT-3 cord may be used on an appliance not mounted on wheels, casters, or the equivalent.

20.3.8 The cord length shall be not less than:

a) 1.8 m for an appliance provided with casters; or

b) 1.5 m for an appliance not provided with casters.

The cord length shall be measured from the face of the attachment plug to the point of entry into the appliance.

20.3.9 A flexible cord shall be provided with strain relief so that stress on the cord will not be transmitted to terminals, splices, or internal wiring.

20.3.10 Except as specified in Clause 20.3.12, a strain relief shall be constructed so that the flexible cord, when installed as intended, does not contact the edges of the opening in which the strain relief is mounted.

20.3.11 The flexible cord shall be provided with a means to reduce the likelihood of the cord's being pushed into the appliance through the cord-entry hole if such displacement:

a) could subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated; or

b) could reduce spacings, such as to a metal strain-relief clamp, below the minimum acceptable values.

20.3.12 If a knot in a flexible cord serves as strain relief, a surface against which the knot might bear or with which it might come in contact shall be free from projections, sharp edges, burrs, fins, or the like that could result in abrasion of the insulation of the cord.

20.3.13 When tested as described in Clause 20.3.14, a strain-relief device shall withstand for 1 min, without displacement, a direct pull of 155 N applied to the cord, with the connections within the appliance disconnected.

20.3.14 A 16 kg weight shall be suspended on the cord and supported by the appliance so that the strain-relief device will be stressed from any angle that the construction of the appliance permits. The strain relief is not acceptable if there is movement of the cord, at the point of disconnection of the conductors, to indicate that stress would have resulted on the connections.

20.4 Bushings

20.4.1 The edges of an opening through which flexible cord passes, including the opening in a strain relief or bushing, shall be smooth and free from burrs, fins, projections, sharp edges and the like that could result in abrasion of the insulation of the cord.

20.4.2 If an insulating bushing is provided in an opening through which a power-supply cord passes, and if the bushing is of material other than ceramic, phenolic, or cold-moulded composition, fibre, or other material that has been investigated and found to be acceptable for the application, the opening shall be smooth and free from burrs, fins, projections, sharp edges, and the like that could result in abrasion of the cord.

21 Terminals for external conductors

21.1 Wiring terminals or leads intended for connection of the conductors of the supply circuit shall be acceptable for the connection of conductors having an ampacity not less than the rating of the branch-circuit marked on the appliance. Leads for supply connection are acceptable only for appliances requiring 12 AWG (3.3 mm^2) or smaller supply conductors.

21.2 A wiring terminal shall be provided with a soldering lug or with a pressure terminal connector securely fastened in place (ie, firmly bolted or held by a screw). A connection device that depends on solder shall not be used for the connection of an equipment-bonding conductor. 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 position.

21.3 A wiring terminal shall be provided with a means to reduce the likelihood of turning.

21.4 A wire-binding screw shall thread into metal.

21.5 A wire-binding screw at a wiring terminal shall not be smaller than No. 10 (M5). A No. 8 (M4) screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor.

21.6 A terminal plate tapped for a wire-binding screw shall be of metal not less than 1.27 mm thick and shall provide not less than two full threads in the metal.

Note: An alloy plate not less than 0.76 mm thick may be used if the tapped threads have adequate mechanical strength.

21.7 A terminal plate may have the metal extruded at the tapped hole to give the thickness necessary for not less than two full threads, provided the thickness of the unextruded metal is not less than the pitch of the thread.

21.8 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in Clause 21.1, but not smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

21.9 The free length of a lead inside an outlet box or wiring compartment shall be 152 mm or more if the lead is intended for field connection to an external circuit.

21.10 An appliance constructed so that it could be adapted upon installation for either of two different supply voltages, such as 120 V, 2-wire or 120/240 V, 3-wire, shall be provided with a terminal block or board on which the appropriate connections can be made during field installation without the necessity of changing or disrupting internal wiring or connections other than at the terminal block.

21.11 An appliance provided with wiring terminals or leads and rated 125 V or 125/250 V or less and employing:

a) a lamp- or element-holder of the Edison-screw-shell type;

b) a single-pole switch; or

c) a single-pole automatic control

shall have one terminal or lead identified for connection of the grounded conductor of a supply circuit.

The terminal or lead intended to be connected to a grounded conductor of a supply circuit shall be the one that is connected to the screw shells of lamp- or element-holders. The terminal or lead intended to be connected to an ungrounded conductor of a supply circuit shall be the one that is connected to single-pole switches or single-pole automatic controls.

21.12 A terminal for connection of the grounded conductor of a supply circuit shall be of, or plated with, a silver-coloured metal. Such a terminal shall be readily distinguishable from the other terminals, or identification of the terminal shall be clearly shown in some other way, such as on an attached wiring diagram.

21.13 A lead for connection of the grounded conductor of a supply circuit shall have a white or grey colour and shall be readily distinguishable from the other leads.

22 Provision for grounding

Note: The term ″grounding″ as used in this clause relates to ″bonding″ in Canada.

22.1 General

22.1.1 In an appliance intended to be permanently connected to the power supply, all exposed non-current-carrying metal parts that could become energized and all non-current-carrying metal parts within the enclosure that are exposed to contact during any servicing operation and that could become energized shall be conductively connected to the equipment-bonding terminal or lead (see Clauses 22.4.1 to 22.4.5).

22.1.2 For an appliance provided with a power-supply cord and an attachment plug for connection to the power supply, the supply cord shall contain a bonding conductor for connecting the equipment to ground.

Note: A portable appliance provided with a system of double insulation need not comply with this requirement.

22.1.3 Except as specified in Clause 22.1.4, the bonding conductor of a flexible power-supply cord shall be:

a) bare or provided with insulation having an outer surface that is green with or without one or more yellow stripes;

b) connected to the grounding blade of an attachment plug of the grounding type; and

c) conductively connected to all exposed non-current-carrying metal parts that could become energized and all non-current-carrying metal parts within the enclosure that are exposed to contact during any servicing operation and that may become energized.

22.1.4 With reference to Clause 22.1.3, the bonding conductor of the power-supply cord of a nonautomatic appliance may be connected to the motor frame only and not to the enclosure of the appliance, provided that the:

a) only electrical components of the appliance are the motor and power-supply cord;

b) power-supply cord enters the motor without being attached to or passing through any other part of the appliance; and

c) motor is mounted in resilient mounting rings that provide between the frame of the motor and all other non-current-carrying metal parts of the appliance:

1) a spacing of not less than 3.2 mm; and

2) insulation resistance of not less than 50 000 Ω.

22.1.5 A non-current-carrying metal part within the enclosure need not be bonded to ground, provided the appliance is marked in accordance with Clause 5.1.2.7.

22.1.6 With reference to the requirements of Clause 22.1.3(c), the connection shall be made by a means not likely to be removed during ordinary servicing not involving the power-supply cord. Solder alone shall not be used for making this connection.

22.1.7 With reference to the requirements in Clauses 22.1.1 and 22.1.3, the following non-current-carrying metal parts are not considered as being likely to become energized:

a) a small metal part such as an adhesive-attached foil marking, a screw, or a handle that is:

1) on the exterior of the enclosure and separated from all electrical components by grounded metal; or

2) electrically isolated from all electrical components;

b) a panel, cover, or other metal part that is isolated from all electrical components, including wiring, by a barrier or vulcanized fibre, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 0.8 mm thick and secured in place;

c) a panel, cover, or other metal part that does not enclose uninsulated current-carrying parts and that is electrically isolated from other electrical components; and

d) a door or the like that could only become energized through a grounded part.

22.1.8 Servicing, as mentioned in Clauses 22.1.1 and 22.1.3, is considered to include the repair of the appliance by a qualified service personnel as well as by the user.

22.1.9 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.

22.1.10 In Canada, bonding of electrical equipment forming part of an appliance shall comply with CAN/CSA-C22.2 No. 0.4.

22.2 Bonding means

22.2.1 A bonding conductor shall be copper, copper alloy, or other material that has been investigated and found to be acceptable for use as an electrical conductor. A ferrous metal part in the grounding path shall be protected against corrosion by enamelling, galvanizing, plating, or other equivalent means.

22.2.2 A bonding conductor shall:

a) be protected from mechanical damage or be located within the enclosure; and

b) not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is not likely to be omitted after removal and replacement of the fastener.

22.2.3 Bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, or by welding or soldering and brazing for materials having a softening or melting point more than 454°C.

22.2.4 The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel.

22.2.5 Among the factors to be taken into consideration when judging the acceptability of a clamping device are the:

a) effect of assembling and disassembling the appliance for servicing; and

b) likelihood that the device will not be reassembled in its intended manner.

22.2.6 If the adequacy of a bonding connection cannot be determined by examination, it shall comply with the requirement in Clause 22.2.11.

22.2.7 A bonding conductor shall have a cross-sectional area not less than that of the bonding conductor of the power-supply cord.

22.2.8 A bonding conductor:

a) may be smaller than specified in Clause 22.2.7 if it complies with the requirements in Clause 22.2.12; or

b) for a component or separate electrical enclosure, may be smaller than specified in Clause 22.2.7, but shall not be smaller than the conductors supplying power to the component or components within the separate enclosure.

22.2.9 A bonding conductor intended to be permanently connected to the power supply shall not be smaller than the size specified in Table 5, except as provided in Clause 22.2.8.

22.2.10 If more than one rating of the branch-circuit overcurrent-protective device is involved, the size of the bonding conductor shall be based on the rating of the overcurrent device intended to provide protection against ground-fault for the component bonded by the conductor. For example, if a motor is individually protected by a branch-circuit overcurrent device of lesser rating than other overcurrent devices used with the appliance, a bonding conductor for that motor shall be sized on the basis of the overcurrent device intended for protection of the motor under ground-fault conditions.

22.2.11 If a test is needed to determine the adequacy of a bonding connection, the connection shall not open when carrying a current equal to twice the rating of the branch-circuit overcurrent device for the time specified in Table 6.

22.2.12 A bonding conductor having a cross-sectional area less than that of the bonding conductor of the power-supply cord and the bonding connections may be used if the connection does not open when carrying a current of 200% of the rating of the appropriate branch-circuit protective device for the time specified in Table 6.

22.3 Continuity of grounding circuit

22.3.1 The resistance between the point of connection of the equipment-bonding means, at or within the appliance, and any point in the grounding circuit shall not be more than 0.1 Ω.

22.3.2 With reference to Clause 22.3.1, the resistance may be determined by any convenient method. However, if unacceptable results are obtained, an alternating current of at least 20 A from a source of supply of not more than 12 V shall be passed from the point of connection of the equipment-bonding means to a metal part in the grounding circuit, and the resulting drop in potential shall be measured between these two points. The resistance shall be determined by dividing the drop in potential in volts by the current in amperes passing between the two points. The bonding conductor of a power-supply cord shall not be included in this measurement.

22.4 Grounding terminals and leads

22.4.1 A wiring terminal or lead for attaching an equipment-bonding conductor shall be provided and shall comply with the requirements in Clause 21.

22.4.2 A terminal for attaching an equipment-bonding conductor shall be such that the equipment-bonding conductor can be connected either inside or outside the appliance.

Note: A terminal that is placed in close proximity to the terminal box or wiring compartment so as not to expose the equipment-bonding conductor to damage may be such that the conductor can be connected only inside the appliance, or only outside the appliance.

22.4.3 A wire-binding screw intended for the connection of an equipment-bonding conductor shall have a green-coloured head that is hexagonal, slotted, or both. A pressure terminal connector intended solely for the connection of such a conductor shall be marked in accordance with Clause 5.1.2.22. The wire-binding screw or pressure terminal connector shall be located so that it does not require removal during normal servicing of the appliance. A sheet-metal screw shall not be used for connection of an equipment-grounding conductor.

Note: The ground screw may be provided with a secondary means of rotation.

22.4.4 A lead intended for attaching an equipment-bonding conductor shall not be smaller than the wire to which it is intended to be connected.

22.4.5 The surface of an insulated lead intended solely for the connection of an equipment-bonding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

23 Screws and connections

23.1 Screws or other fastenings of fragile insulating parts shall not be so tight as to result in cracking or breaking of such parts due to expansion and contraction, unless the insulating material is completely retained. Generally, such parts shall be slightly loose or shall be provided with cushioning material.

24 Creepage distances, clearances, and distances through insulation

24.1 General

24.1.1 Spacings between uninsulated current-carrying parts of opposite polarity, between uninsulated parts of low-voltage and line voltage circuits, and between an uninsulated current-carrying part and a non-current-carrying metal part, shall not be less than the values specified in Table 7. If an uninsulated current-carrying part is not rigidly fixed in position, by means other than friction between surfaces, or if a movable non-current-carrying metal part is in proximity to an uninsulated live part, the construction shall be such that the acceptable minimum spacing is maintained.

24.1.2 The spacing between parts of different circuits shall not be less than the largest spacings required for parts of opposite polarity for the circuits involved.

24.1.3 The spacing requirements specified in Clause 24.1.1 do not necessarily apply to the inherent spacings of a component of the appliance, such as a snap switch, lampholder, motor, or other device. Such spacings shall comply with the requirements for the component in question if they are smaller than the values specified in Table 7.

24.1.4 Film-coated wire shall be regarded as an uninsulated current-carrying part when spacings are being considered.

24.1.5 At terminal screws and studs to which connection could be made in the field by means of wire connectors, eyelets, or the like, the spacings shall not be less than those specified in Table 7 when the connectors, eyelets, or the like are in such position that minimum spacings exist between:

a) current-carrying parts;

b) current-carrying parts of opposite polarity; or

c) current-carrying parts and non-current-carrying metal parts.

24.1.6 An insulating liner or barrier of vulcanized fibre or similar material employed in lieu of spacings shall:

a) not be less than 0.8 mm thick; and

b) be located so, or of such material that, it will not be adversely affected by arcing.

Fibre not less than 0.4 mm thick may be used in conjunction with an air spacing of not less than 50% of the spacing required for air alone.