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Table 25.1 Continued

[a] UL 60730-1, Table 1 item number	Information	Control requirement
[e] Pollution Degree 2 applies except when the manufacturer declares Pollution Degree 3 due to exposure of condensation or water to the control during normal operation.		

25.7 If a temperature-regulating control installed as part of the water heater has a marked or displayed OFF position, the control shall directly or indirectly disconnect the heating elements that it controls from the ungrounded heating element circuit conductors, and shall not respond to temperature when placed in the OFF position.

25.8 A commercial storage tank water heater temperature-regulating control shall be set before leaving the factory to a control position corresponding to a setting of 60°C (140°F) or less. This setting may be approximate as in the case of a marking that reads ″Low-Medium-High″ or the equivalent, instead of directly in degrees C or F.

26 Terminals and Sensing Elements of Temperature-Regulating and Temperature-Limiting Controls

26.1 The bulb, capillary tubing, or other sensing element of a temperature-limiting control that is depended upon to reduce the risk of fire, electric shock, or injury to persons, or of a temperature-regulating control that regulates the output water temperature, shall be located or shielded so that it is not subjected to mechanical damage during field installation or subsequent use of the water heater.

26.2 Water heaters that require partial disassembly or that are constructed to permit rearrangement of internal parts at the time of installation shall afford components referenced in 26.1 protection from mechanical damage during field installation or subsequent use of the water heater.

27 Materials in Contact with Water

27.1 General

27.1.1 A nonmetallic material in contact with water shall conform to the requirements of the National Sanitation Foundation Standard for Plastics Piping Components and Related Materials, NSF No. 14 with regard to toxicity, taste, color, solubility, and odor; and shall have a specific gravity greater than 0.94.

27.1.2 Lead shall not be used as an intentional ingredient for any material in contact with water in a water heater.

27.2 Dip tubes

27.2.1 A dip tube shall be provided with an antisiphoning hole located so that, after the dip tube is installed, the hole is within 6 inches (152 mm) of the top of the tank.

27.2.2 A dip tube having a specific gravity less than 1.0 shall be held in place by a positive means that limits any vertical displacement to no more than 1/4 inch (6.4 mm).

27.2.3 A nonmetallic dip tube shall comply with the tests described in Section 44, Nonmetallic Dip Tube Tests.

28 Spacings

28.1 The spacings in a water heater shall be no less than those indicated in Table 28.1 and 28.2 – 28.8.

28.2 The spacings specified in Table 28.1 do not apply to the inherent spacings of a component part of a water heater. Such spacings are judged under the requirements for the component.

Table 28.1
Minimum acceptable spacings

Parts involved	0 – 250 Volts				251 – 600 Volts			
	Through air		Over surface		Through air		Over surface	
	Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)
Between a live part and the enclosure	1/2	(12.7)	1/2	(12.7)	1/2	(12.7)	1/2	(12.7)
Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part and a dead metal part which is exposed to contact by persons or which may be grounded[a]	1/8	(3.18)	1/4	(6.35)	1/4	(6.35)	3/8	(9.6)
[a] If an uninsulated live part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live part, the construction is to be such that the minimum spacing will be maintained under all operating conditions.								

28.3 At closed-in points only, such as the screw-and-washer construction of an uninsulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) is acceptable on a water heater rated 250 volts or less. Within a thermostat, other than at contacts, the spacing between uninsulated live parts on opposite sides of the contacts shall be no less than 1/32 inch (0.8 mm) through air and 3/64 inch over the surface of insulating material, and the construction shall be such that the spacings are maintained permanently.

28.4 Whether through air or over the surface, a closed-in spacing is considered to be that in the enclosed space formed by a live conductor passing through an opening in dead metal, as well as through an insulating washer on each side of the metal. The assembly is secured firmly in place, usually by a nut threaded on the live conductor on each side of the exterior of the assembly.

28.5 An insulating lining or barrier of fiber or similar material employed where spacings would otherwise be sufficient shall be no less than 1/32 inch (0.8 mm) in thickness, and shall be so located or of such material that it is not adversely affected by arcing.

Exception: Fiber no less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing no less than 50 percent of the spacing required for air alone.

28.6 Unless protected from mechanical abuse during assembly and intended functioning of the water heater, a barrier of mica shall be 0.010 inch (0.25 mm) or more in thickness.

28.7 Spacings in a low voltage safety control circuit shall comply with the requirements in 28.1 – 28.6.

28.8 The spacing between uninsulated live parts of opposite polarity and between such parts and dead metal that may be grounded in service may be less than indicated in Table 28.1 for parts of a low voltage circuit.

29 Grounding

29.1 A permanently connected water heater shall be provided with a field wiring terminal or lead for connection of an equipment grounding conductor. The terminal or lead shall be constructed in accordance with 11.3. Sheet-metal screws shall not be used:

a) To connect grounding conductors to enclosures; nor

b) To provide for the connection of the branch circuit equipment grounding conductor.

29.2 In a water heater intended to be permanently connected to the power supply, all exposed dead metal parts that may become energized and all dead metal parts within the enclosure that are exposed to contact during any servicing operation and that may become energized shall be conductively connected:

a) To the enclosure at the point of connection of the wiring system; and

b) To the equipment grounding terminal or lead.

29.3 For a cord connected water heater, the power supply cord or cord set shall have an equipment grounding conductor.

29.4 An equipment grounding conductor of a flexible power supply cord shall be:

a) 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;

c) Conductively connected to all exposed dead metal parts that may become energized and all dead metal parts within the enclosure that are exposed to contact during any servicing operation and that may become energized; and

d) Conductively connected to the enclosure of the water heater.

29.5 With reference to the requirements in 29.2 and 29.4, the following dead 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, a handle, or the like – 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, a cover, or other metal part that is isolated from all electrical components, including wiring, by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture resistant insulating material no less than 1/32 inch (0.8 mm) thick and secured in place.

c) A panel, a cover, or other metal part that does not enclose uninsulated live parts and that is electrically isolated from other electrical components.

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

29.6 Servicing, as mentioned in 29.2 and 29.4, is considered to include repair of the water heater by qualified service personnel as well as by the user.

29.7 With reference to the requirements in 29.4 (c) and (d), the connection shall be made by a screw or other means not likely to be removed during servicing not involving the power supply cord. Solder alone shall not be used for making this connection.

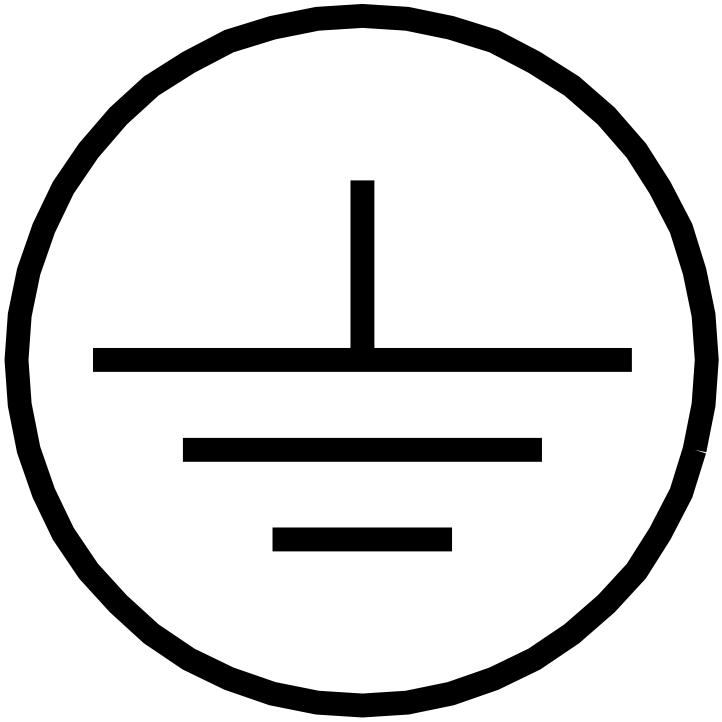
29.8 A field wiring terminal intended solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the size indicated in 29.12.

29.9 The surface of a lead visible in a wiring compartment in which field connections are made, and intended 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 finished.

29.10 The requirements in 29.9 relating to color coding for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

29.11 A wire binding screw intended for the connection of an equipment grounding conductor shall have a green colored head that is slotted, hexagonal shaped, 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″, ″GROUNDING″, the grounding symbol illustrated in Figure 29.1, or by a marking on an attached wiring diagram. See 59.7. The wire binding screw or pressure wire connector shall be located inside the terminal compartment and in a manner that will make it unlikely to be removed during routine servicing of the water heater.

Figure 29.1
Grounding symbol



29.12 The size of a conductor or strap employed to bond an electrical enclosure shall be based on the rating of the branch circuit overcurrent device to which the equipment is connected.

Exception: An equipment grounding conductor no smaller than 18 AWG (0.82 mm^2) copper and no smaller than the circuit conductors that is an integral part of a flexible cord assembly may be used to ground cord connected equipment if the equipment is protected with an attachment plug-cap rated at 15 or 20 amperes.

29.13 A soldering lug, a push-in (screwless) connector, or a quick connect or similar friction fit connector shall not be used for the grounding terminal.

Exception: An internal connector for bonding non-current carrying parts for grounding continuity purposes (excluding a field installed grounding conductor or the grounding conductor of a supply cord) may employ a quick connect terminal of the dimensions specified in Table 29.1, provided the connector is not likely to be displaced and provided the heater is limited to use on a circuit having a branch circuit protective device specified in Table 29.1.

Table 29.1
Size of quick connect terminals

Connector size, inch (mm)	Rating of protective device, amperes
0.020 x 0.187 x 1/4 (0.51 x 4.75 x 6.4)	20
0.032 x 0.187 x 1/4 (0.81 x 4.75 x 6.4)	20
0.032 x 0.205 x 1/4 (0.81 x 5.21 x 6.4)	20
0.032 x 1/4 x 5/16 (0.81 x 6.4 x 7.9)	60

29.14 Grounding and bonding equipment used to comply with this Section and other applicable requirements of this standard shall comply with the Standard for Grounding and Bonding Equipment, UL 467.

30 Motors

30.1 General

30.1.1 The enclosure of a motor shall have no openings which will permit a drop of liquid, or a particle falling vertically onto the motor, to enter the motor as applied to the assembly.

30.1.2 Conformance to 30.1 may be provided by the motor frame or by another enclosure, structure, shield, or a combination of two or more such items, and is to be determined with the motor applied to the assembly.

30.1.3 Motors having openings in the enclosure or frame shall be installed or shielded to prevent particles from falling out of the motor onto combustible material located within or under the assembly.

30.1.4 The requirement in 30.1.3 will necessitate the use of a barrier of nonflammable material under an open type motor unless:

a) The structural parts of the motor such as the bottom closure, provide the equivalent of such a barrier; or

b) The motor overload protection device provided with a single-phase 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, as applicable to the particular type of motor:

1) Open main winding;

2) Open starting winding;

3) Starting switch short-circuited; and

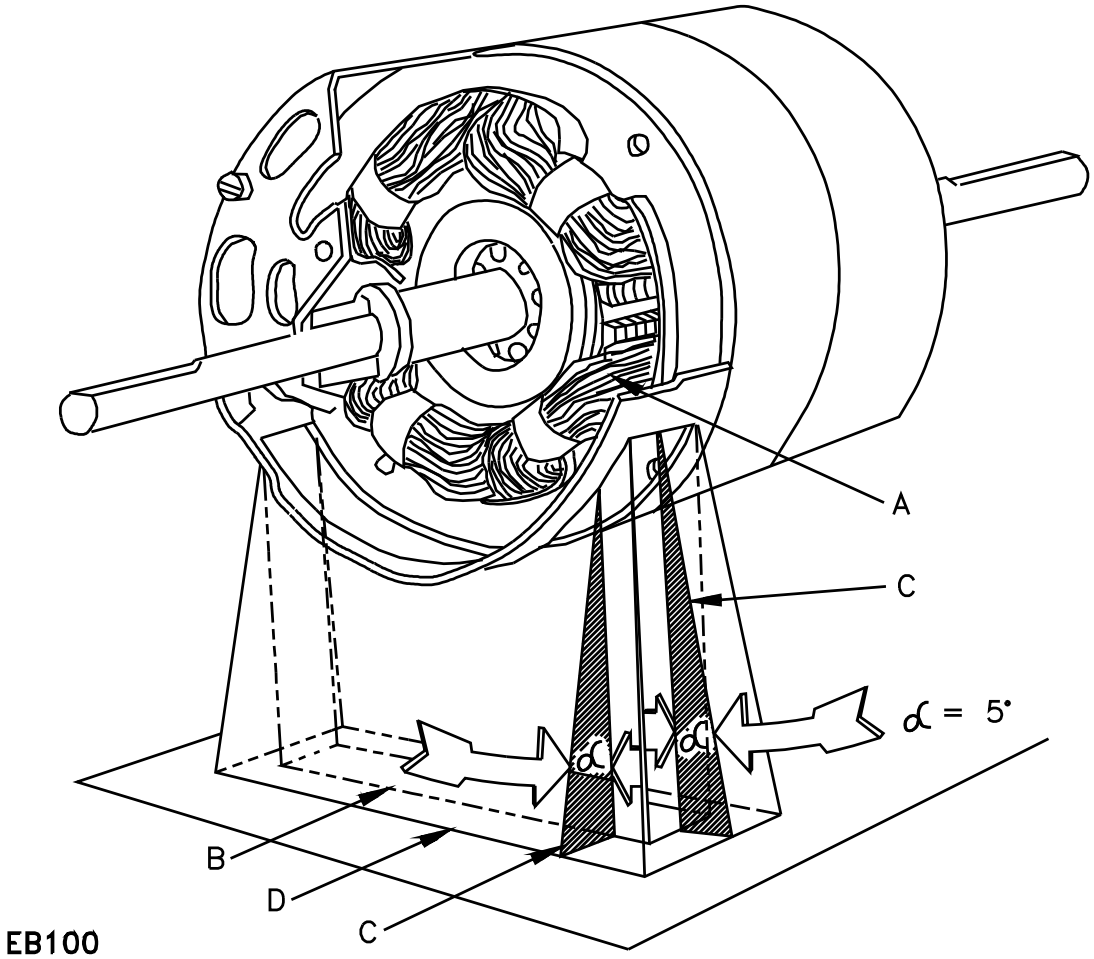
4) Capacitor shorted, permanent split capacitor type; or

c) The motor is provided with a motor protector in accordance with 30.2 that will prevent the temperature of the motor windings from becoming more than 125°C (275°F) under the maximum load below which the motor will run without causing the protector to cycle and from becoming more than 150°C (302°F) with the rotor of the motor locked.

d) The motor complies with the requirements for impedance-protected motors see 30.2.5 and the motor winding will not exceed a temperature greater than 150°C (302°F) during the first 72 hours of operation with the rotor of the motor locked.

30.1.5 The barrier mentioned in 30.1.4 shall be horizontal, and have an area not less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier provided that such openings would not permit molten metal, burning insulation, or the like to fall on combustible material.

Figure 30.1
LOCATION AND EXTENT OF BARRIER



A – Motor winding to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding which is partially shielded by the motor enclosure or equivalent.

B – Projection of outline of motor winding on horizontal plane.

C – Inclined line which traces out minimum area of the barrier. When moving, the line is to be always:

1) tangent to the motor winding;

2) 5 degrees from the vertical; and

3) so oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is to be that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

30.1.6 A motor shall be designed for continuous duty as indicated by the designation ″CONTINUOUS″ or ″CONT″ on the nameplate.

30.1.7 Motors shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

30.1.8 Capacitors shall comply with the Standard for Capacitors, UL 810.

30.2 Motor overload protection

30.2.1 Fuses shall not be used as motor overload protective devices unless the motor is adequately protected by the largest size fuse which can be inserted in the fuseholder.

30.2.2 In no case shall interruption of the circuit to a motor by the overcurrent or thermal protective device result in a risk of fire, electric shock, or injury to persons during operation of the equipment.

30.2.3 Automatic-reset type protective devices shall not be used if the automatic reclosing of the circuit to the motor by the device may result in a risk of fire, electric shock, or injury to persons during operation of the equipment.

30.2.4 All single-phase motors shall be protected by one or more of the following:

a) A separate device responsive to motor current and rated or set to trip at not more than the percentage of the motor nameplate full-load current rating as specified in Table 30.1.

b) A separate overload device, which combines the functions of overload and overcurrent protection and is responsive to motor current. Such a device shall be set at values not greater than the percentages of the motor nameplate full-load current rating as specified Table 30.1.

c) A thermal protective device or impedance protection complying with the Standard for Thermally Protected Motors, UL 1004-3 or the Standard for Impedance Protected Motors, UL 1004-2. If a motor protective electronic circuit relies on software as a protective component, that part of the software providing the required motor protection shall comply with software Class 1 in the Standard for Software in Programmable Components, UL 1998 or software Class B in Annex H of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1. |

d) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2.

Exception: Impedance protection may be accepted for motors which are determined to be adequately protected against overheating due to locked-rotor current, provided it is determined that the motor will not overheat under the performance requirements of this standard.

e) A protective device integral with the motor that complies with the Standard for Thermally Protected Motors, UL 1004-3. 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 required to have locked-rotor protection only.

f) Protective electronic circuits integral to the motor that comply with the Standard for Electronically Protected Motors, UL 1004-7.

g) Protective electronic circuits that comply with 30.2.6.

h) Other protection that is shown by test to be equivalent to the protection specified in (a) to (g).

30.2.5 In reference to 30.2.4 (a) and (b), if the percentage protection specified in Column A of Table 30.1 does not correspond to the percentage value of an overload device of a standard size, the device of the next higher size may be used. However, the device of the next higher size shall provide protection no higher than that indicated in Column B of Table 30.1.

Table 30.1
Overload relay size

	Maximum percentage protection	
	A	B
Motor with a marked service factor no less than 1.15	125	140
Motor with a marked temperature rise no more than 40°C (72°F)	125	140
Any other motor	115	130

30.2.6 Except as indicated in 30.2.4 (c) and (f), a protective electronic circuit providing motor protection shall comply with one of the following:

a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. When the protective electronic circuit is relying upon software as a protective component, that part of the software providing the required motor protection shall comply with the Standard for Software in Programmable Components, UL 1998. If software is relied upon to perform a safety function, it shall be considered software Class 1.

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 as well as the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9. If software is relied upon to perform a safety function, it shall be considered software Class B.

Exception: A protective electronic circuit providing motor protection is not required to comply with UL 991 or UL 60730-1 if there is no risk of fire, electric shock or casualty hazard during abnormal testing with the protective electronic circuit rendered ineffective. The need for software to comply with UL 1998 or UL 60730-1 can be based on the actual construction and operation of the motor within the equipment. This could include a consideration of the protective electronic circuit being provided with independent redundant protective devices.

30.2.7 With reference to 30.2.6, the factors outlined in Table 30.2 shall be considered when judging the acceptability of a protective electronic circuit.