UL 399

STANDARD FOR SAFETY

Drinking Water Coolers

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UL Standard for Safety for Drinking-Water Coolers, UL 399

Eighth Edition, Dated March 30, 2017

Summary of Topics

This revision of ANSI/UL 399 dated February 28, 2024 includes a change in requirements for Compliance to UL 4200A for Water Coolers Using Button Cell Batteries; 18.2.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated January 19, 2024.

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Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover self-contained drinking-water coolers employing hermetic refrigerant motor-compressors or thermoelectric water chilling systems and designed for connection to alternating-current circuits rated not greater than 600 volts in accordance with the National Electrical Code, NFPA 70. The following types of water coolers are included within the scope of this Standard:

a) Those supplying cold water or both cold and hot water;

b) Battery operated;

c) Those employing flammable refrigerant as defined in Supplement SB; and

d) Those provided with ultraviolet (UV) radiation lamp systems in which the UV wavelengths are 200 nm or greater; however, the effectiveness of the water treatment by the UV radiation is not covered by these requirements.

1.2 These requirements do not include additional requirements applicable to equipment designed for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Units of measurement

2.1 If a value for measurement is followed by value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

3 Undated references

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4 *Reserved for future use*

5 Glossary

5.1 For the purpose of this standard, the following definitions apply.

5.2 ACCESSORY – An optional electrical device or other component, such as a superstructure, intended for installation in or connection to a water cooler for the purpose of modifying or supplementing the functions of the water cooler. It may be factory installed or intended for installation by the user.

5.3 *ADJUSTABLE SPEED DRIVE – A combination of power converter, inverter, motor, and motor-mounted auxiliary devices such as encoders, tachometers, thermal switches and detectors, air blowers, heaters, and vibration sensors.

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5.4 *ADJUSTABLE SPEED DRIVE SYSTEM – An interconnected combination of equipment that provides a means of adjusting the speed of a mechanical load coupled to a motor. A drive system typically consists of an adjustable speed drive and auxiliary electrical apparatus.

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5.5 BARRIER, ELECTRICAL – A partition for the isolation of high-voltage electrical components or for separating ignition sources from flammable materials.

5.6 BARRIER, MECHANICAL – A rigid partition for the isolation of moving parts and ultraviolet (UV) radiation, or protection of wiring.

5.7 BASIC INSULATION – The insulation applied to live parts to provide protection against electric shock.

5.8 CABINET – The part of the product that provides physical protection to insulated wiring, enclosures, moving parts, motors, enclosed electrical parts, refrigeration tubing or other parts that may cause injury to persons.

5.8.1 CAPACITOR, CLASS Y – Capacitor or resistor-capacitor unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock. (Examples would include capacitors connected across the primary and secondary circuits where electrical isolation is required to prevent an electric shock or between hazardous live parts and accessible parts.)

5.9 CAPILLARY TUBE – Device made of tubing with an outer diameter of less than 3/16 inch (4.7 mm) and used to reduce the pressure of the refrigerant between the condenser and evaporator. It also regulates the refrigerant flow.

5.10 CIRCUITS, ELECTRICAL:

Extra-Low-Voltage – A circuit supplied by:

1) An AC potential of not more than 42.4 volts peak (30 V rms) and power of 100 VA or less; or

2) A DC potential of 30 V supplied by a primary battery; or

3) A Class 2 transformer, as defined by the National Electrical Code, NFPA 70; or

4) A combination of an isolating transformer and fixed impedance which, as a unit, complies with all performance requirements for a Class 2 transformer.

High-Voltage – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of an extra-low-voltage circuit.

5.11 COMPONENT – A device or fabricated part of the drinking water cooler covered by the scope of a safety standard dedicated to that purpose. If incorporated in a drinking water cooler, a product that is otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in

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performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

5.12 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential risk of fire, electrical shock, or injury to persons, is considered an operating control. Operating controls are also referred to as "regulating controls". Appendix B specifies control functions that are not considered to result in a risk of fire, electric shock or injury to persons.

5.13 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as "limiting controls" or "safety controls" and are investigated under normal and single-fault conditions. Appendix B specifies control functions that are considered to result in a risk of fire, electric shock or injury to persons.

5.14 DOUBLE INSULATION – An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and arranged so that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, and the like) to the same degree.

5.15 ELECTRONIC COMPONENT – A part in which electrical conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor. A Metal Oxide Varistor (MOV) is considered to be an electronic component, but neon indicators are not.

5.16 ELECTRONIC DISCONNECTION – The de-energizing of a load within an appliance by an electronic device of a circuit. No electro-mechanical component having an air gap, such as a switch, contactor or relay is used to de-energize the load.

5.17 ENCLOSURE – The part of the product that does one or more of the following:

a) Isolates ignition sources;

b) Renders inaccessible all or any parts of the equipment that may otherwise present a risk of electric shock;

c) Retards propagation of flame initiated by electrical disturbances within.

5.18 FUNCTIONAL PART – A part other than an enclosure or cabinet used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure.

5.19 GROUNDING, FUNCTIONAL – Grounding of a point in an appliance which is necessary for a purpose other than safety.

5.20 IGNITION SOURCE – Any high-voltage electrical component not located within an enclosure.

5.21 MAXIMUM OPERATING CURRENT (MOC) – The current resulting when an electric motor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor/adjustable speed drive or drive system is at a maximum.

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5.22 MAXIMUM RATED CURRENT (MRC) – The current resulting when a hermetic refrigerant motor-compressor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor-compressor/adjustable speed drive or drive system is at a maximum.

5.23 MOTOR CONTROLLER – Any device normally used to start and stop a motor, such as a switch, thermostat, pressure limiting control, or the like.

5.24 NONFUNCTIONAL PART – A part of the product that does not perform a specific function.

5.25 NONFUNCTIONAL PART, SMALL – A nonfunctional part that does not occupy a volume greater than 0.12 in^3 (2 cm^3), does not have a dimension greater than 1.2 inches (3 cm), is located so it cannot propagate flame from one area to another and does not connect a possible source of ignition to other ignitable parts.

5.26 PRECOOLER – A heat exchanger within a water cooler intended to remove heat from the inlet water before the inlet water enters the evaporator. Heat is removed from the inlet water by the cooled outlet (waste) water. The precooler has separate passes between water circuits so that the inlet and outlet water cannot mix.

5.27 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions.

5.28 START-TO-DISCHARGE PRESSURE – The pressure at which a relief valve begins to discharge, typically the pressure where the first bubbles can be seen when a valve is immersed in water.

5.29 SUPPLEMENTARY INSULATION – An independent insulation provided in addition to the basic insulation to protect against electric shock in case of mechanical rupture or electrical breakdown of the basic insulation.

5.29.1 SWITCH MODE POWER SUPPLY UNIT – Electronic device incorporating transformer(s) and electronic circuitry(ies), that converts electrical power into single or multiple power outputs by rapidly switching a solid-state device on and off. It may also isolate the input circuit from the output circuit and regulate and/or convert the output voltage and current. The device may consist of one or more individual units with identical or different waveforms and frequencies including dc output.

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5.30 TEMPERATURE LIMITING CONTROL – A control which serves only to prevent abnormal temperature and is not intended to function during normal operation.

5.31 TEMPERATURE REGULATING CONTROL – A control which regulates temperature and is intended to function frequently during normal operation.

5.32 THERMISTOR – A thermally sensitive semiconductor resistor, which shows over at least part of its resistance/temperature characteristic a significant non-linear change in its electrical resistance with a change in temperature. A thermistor may be either of the positive temperature coefficient (PTC) type or of the negative temperature coefficient (NTC) type.

5.33 ULTIMATE STRENGTH – The highest stress level that a refrigerant-containing component can tolerate without rupture.

5.34 ULTRAVIOLET (UV) RADIATION SYSTEM – Equipment that directly generates UV radiation and generally used to enhance purification of the drinking water. The system typically consists of a lamp assembly with UV bulb(s) producing ultraviolet radiation in wavelengths of 200 nm or greater.

5.34.1 VOLTAGE FOLDBACK – A circuit design feature intended to protect the power supply output transistors. When overcurrent is drawn by the load, the supply reduces the output voltage and current to within the safe power dissipation limit of the output transistors.

5.35 WATER COOLER – A unit that consists of a refrigeration system that is intended to cool potable water.

5.36 WATER COOLER, AGAINST-THE-WALL – Freestanding units intended to be placed in close proximity to a wall.

5.37 WATER COOLER, BOTTLE TYPE – A water cooler which employs a bottle or reservoir for storing potable water that is intended to be cooled and utilizes a faucet or similar means to dispense the chilled water.

5.38 WATER COOLER, BUILT-IN – These are intended to be permanently mounted and enclosed to some degree by structural parts of a building. A wall-insert water cooler is an example of a “built-in” type.

5.39 WATER COOLER, CAFETERIA – Pressure-type coolers intended primarily for use in cafeterias and restaurants for dispensing water rapidly into glasses and pitchers.

5.40 WATER COOLER, COLUMN MOUNT – Remote water coolers intended for installation on a column or post usually at an elevated position above the floor.

5.41 WATER COOLER, COUNTER-SUPPORTED – A water cooler that is physically supported by a counter, table or bench during the performance of its intended function.

5.42 WATER COOLER, FREESTANDING – Intended for installations in which the structural parts of a building neither enclose nor functionally obstruct the water cooler.

5.43 WATER COOLER, HOT- AND COLD-TYPE – These include means for heating and dispensing potable water.

5.44 WATER COOLER, PRESSURE TYPE – A water cooler intended to be plumbed to a potable water source that is supplied under pressure. The water cooler utilizes a faucet or similar means to dispense the water.

5.45 WATER COOLER, REMOTE – Pressure-type coolers designed for use with remotely installed bubblers or other dispensing means.

5.46 WATER COOLER, SELF-CONTAINED – Completely factory-made and factory-tested assemblies to which no refrigerant-containing parts are connected in the field.

5.47 WATER COOLER, THERMOELECTRIC – A water cooler in which the water is chilled using the Peltier Effect such that a direct current supply source is applied to a semiconductor thermoelectric module creating a temperature gradient which transfers heat from one surface to another.

5.48 WATER COOLER, WALL-HUNG – Water coolers intended to be suspended from a wall.

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6 Installation And Operating Instructions

6.1 A water cooler shall be provided with installation and operating instructions that contain the following:

a) Directions and information as deemed by the manufacturer to be necessary for the safe installation, maintenance, and use of the water cooler;

b) Roughing-in dimensions for electrical connections of permanently connected units and for plumbing connections of pressure-type units;

c) Guidelines for ensuring protection of the water cooler by means of a ground-fault circuit interrupter; and

d) For pressure type coolers the maximum water supply line pressure shall be included.

6.2 A copy of the manufacturer's installation and operating instructions, or equivalent information intended to accompany each water cooler, shall be furnished with the sample submitted for investigation. These instructions shall be used as a guide in the examination and test of the water cooler.

6.3 If a water cooler is intended for use with a field-installed accessory, instructions for installing the accessory shall be provided on or with the accessory and shall warn the user that:

a) The water cooler must be disconnected from the source of electrical supply before attempting the installation; and

b) The accessory is intended for use only with the specific water cooler for which the accessory is marked.

6.4 A double insulated thermoelectric water cooler provided with a 2-blade, polarized attachment plug shall be provided with the following or equivalent in the manufacturer's installation and operating instructions: “To reduce the risk of electric shock, this appliance has a polarized plug (one blade is wider than the other). This plug will fit in a polarized outlet only one way. If the plug does not fit fully in the outlet, reverse the plug. If it still does not fit, contact a qualified electrician to install the proper outlet. Do not change the plug in any way.”

6.5 A water cooler intended to employ a UV system shall be provided with instructions specifying the following or equivalent:

a) Information indicating the cover or covers that provide access to the UV radiation system along with the following or equivalent statement: “Caution: UV Light Source – Disconnect the electrical source of supply to the UV radiation before opening cover.”

b) Information for the replacement of the UV lamps which shall include the wattage, voltage, lamp type and the designation number; and

c) Instructions pertaining to the proper handling and disposal of UV lamps.

6.6 The instructions for a water cooler employing R744 (carbon-dioxide) shall specify that:

a) The water cooler be installed in a well-ventilated area and that installation in confined spaces shall be avoided; and

b) Users and/or installers follow requirements in the R744 material safety data sheet (MSDS) and in the Safety Standard for Refrigeration Systems, ASHRAE 15.

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6.7 In reference to 22.4, the instructions for a water cooler intended to be remotely operated and in which the water cooler attachment plug and receptacle serve as the manual means for disconnecting remote operation commands, external communication or data signals shall specify that unplugging the water cooler disconnects the remote functions.

6.8 The instructions for a water cooler, and any intended accessory(ies), having two power supply cords:

a) Shall indicate that the water cooler uses two cords and caution against unplugging only one cord during movement, testing or repair of the product; and,

b) That may have different attachment plug caps shall state that different attachment plugs are used and shall specify the electrical rating of each plug. If individual branch circuits are involved, the instructions shall state that individual branch circuits are to be employed to supply the product and electrical ratings of each branch circuit shall be specified.

CONSTRUCTION

7 General

7.1 Ferrous metal parts used to support or retain electrical components in position shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting.

7.2 All nonmetallic parts, excluding small nonfunctional parts shall comply with 8.1, 8.2, and Table 58.1.

7.3 In addition to the requirement in 7.2, nonmetallic materials that serve as electrical insulation or that directly support live parts shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.4 The hot water dispense device on a hot- and cold-type water cooler shall require at least two distinct operations to dispense hot water.

7.5 A component shall:

a) Comply with the safety standard covering that component;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Comply with the applicable requirements of this end product standard; and

e) Not contain mercury.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product, or

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.

7.6 A component that is also required to perform other necessary functions, such as overcurrent protection, ground-fault circuit interruption, surge suppression, any other similar functions, or any

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combination thereof, shall comply additionally with the requirements of the applicable standard(s) covering products that provide those functions.

8 Nonmetallic Material

8.1 Classification

8.1.1 Materials shall be classified with respect to flammability characteristics that are established by the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

8.1.2 Materials shall be assigned flammability ratings based on greatest to least resistance to flame and are identified as: 5VA, 5VB, V-0, V-1, V-2, HF-1, HF-2, HB, and HBF.

8.1.3 In reference to 8.1.2, the assigned flammability rating shall be appropriate for the material-use application in accordance with 8.2 and Table 58.1.

8.1.4 Nonmetallic materials exposed to UV radiation shall comply with the Ultraviolet Light Exposure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C except that the testing shall be conducted based on the actual UV radiation to which the nonmetallic material is exposed rather than the twin enclosed carbon-arc or xenon-arc conditioning. The test shall be conducted for not less than 1000 hours. Following the UV exposure, the materials shall comply with the tests specified in Table 58.1 based on the use application for each nonmetallic material.

8.2 Ignition Sources

8.2.1 Parts formed from nonmetallic materials rated HB or HBF and positioned as shown if Figure 8.2 shall be separated from ignition sources by means of a barrier, extending at least to the boundary surface of the space whenever such part are located:

a) Below an ignition source and within Space A; and

b) Above an ignition source and within Space B; and

c) In the vertical plane relative to an ignition source and within Space C.

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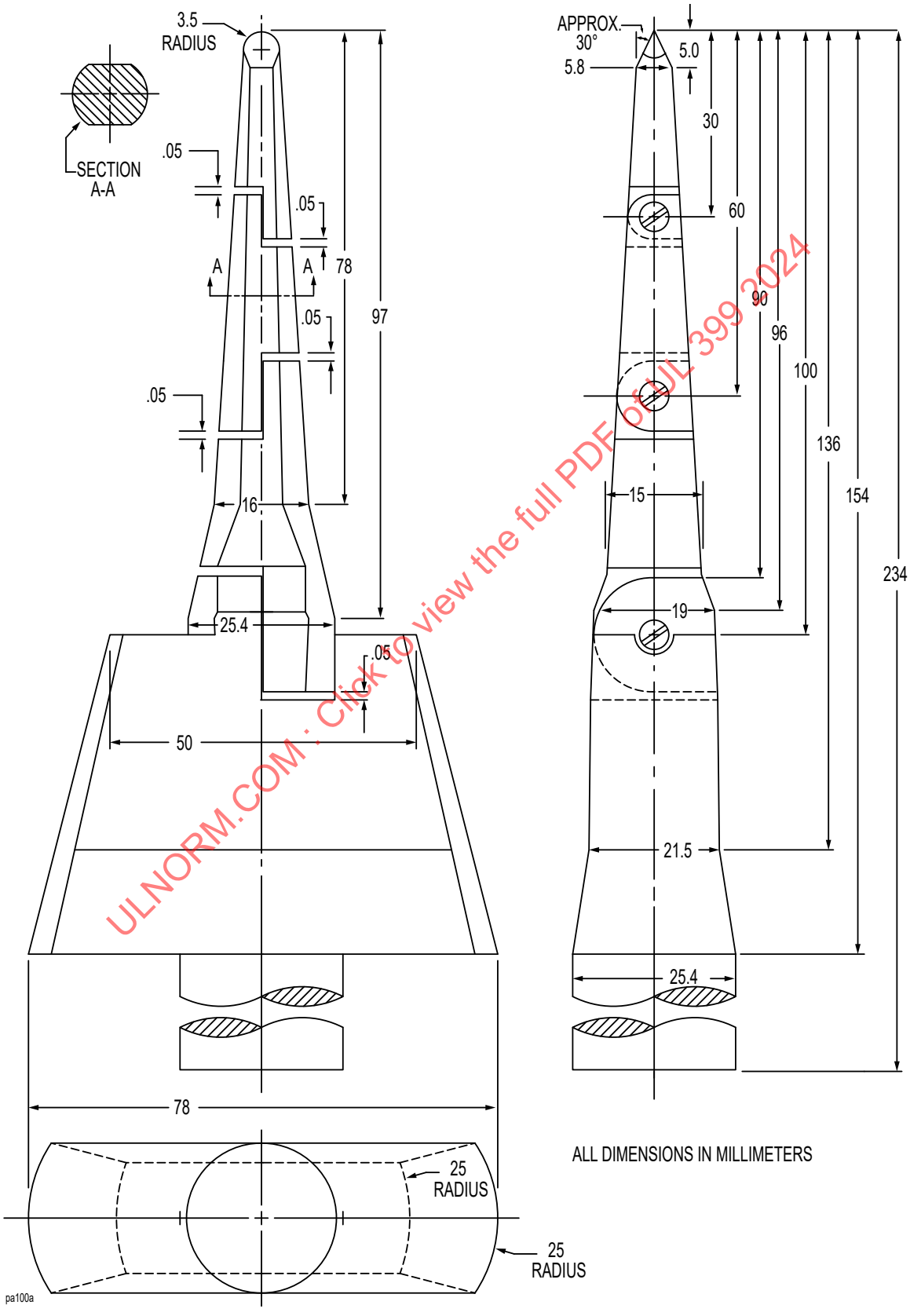
Figure 8.1

Articulate probe with web stop



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8.2.2 The HB or HBF materials referenced by 8.2.1 shall be located such that the distance between:

a) High-voltage wiring not employing VW-1 and the HB or HBF materials shall be a minimum of 2 inches (51 mm), and

b) Any other ignition source and the HB or HBF materials shall be a minimum of 4 inches (102 mm).

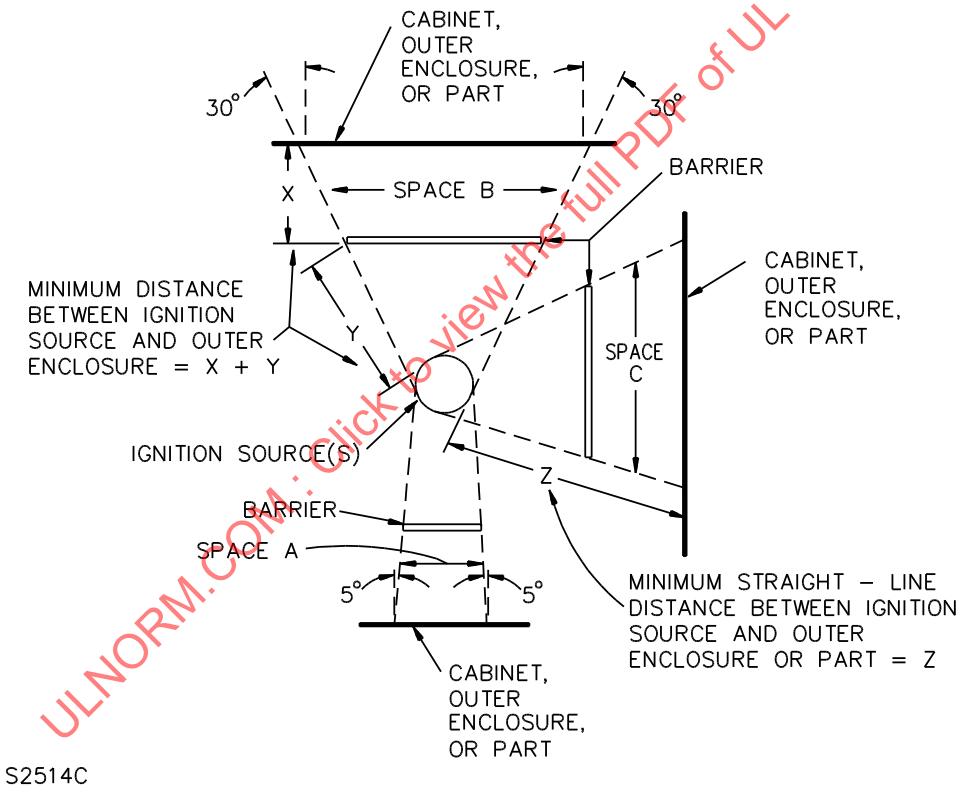
8.2.3 In reference to 8.2.2 and Figure 8.2, the minimum distance for materials located:

a) Above the ignition source shall be as shown in Distance X + Y; and

b) In the vertical plane relative to the ignition source shall be as shown in straight-line Distance Z.

Figure 8.2

Separation of ignition sources from nonmetallic materials



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Notes:

Space A – Represents the volume below the ignition source determined by a straight line that moves about the ignition source while remaining at the angle of 5 degrees from the vertical and is always so oriented that the volume is maximum.

Space B – Represents the volume above the ignition source determined in the same manner as Space A, except that the angle is 30 degrees from the vertical.

8.3 Application and Location

8.3.1 Nonmetallic fasteners used as a part of the enclosure shall comply with the Fastener strength test. See 58.3.

8.3.2 The combined total exposed surface area of all small, nonfunctional parts shall not exceed 144 in^2 (929 cm^2).

8.3.3 When thermal insulation is located between a cabinet and inner liner, the product shall comply with both (a) and (b) or it can comply only with (c):

a) All holes within the cabinet and inner liner shall be closed,

b) The cabinet surfaces shall be securely fastened such that the maximum spacing between screws, spot welds, or other securement means does not exceed 6 inches (152.4 mm),

c) The thermal insulation shall be rated HF-1.

9 Assembly

9.1 General

9.1.1 A bottle-type water cooler shall be assembled so that removal and replacement of bottles will not result in damage to electrical components and wiring, or to refrigerant-containing components.

9.1.2 Ozone generating equipment installed on drinking water coolers shall comply with the Standard for Water Treatment Appliances, UL 979 and with the Ozone Test of Section 71.

9.1.3 If a drinking water cooler contains a refrigerated storage compartment, the compartment shall comply with the requirements in the Standard for Household and Similar Electrical Appliances – Safety – Part 2-24: Particular Requirements for Refrigerating Appliances, Ice-Cream Appliances and Ice-Makers, UL 60335-2-24 that apply to refrigerated compartments.

9.1.4 Wiring and electrical components shall not be exposed to UV radiation.

9.2 Pressurized beverage product system

9.2.1 A gas pressure regulator or reducing valve shall comply with the Standard for Compressed Gas Regulators, UL 252.

9.2.2 A pressure-relief valve complying with either 54.3 or with the Start-To-Discharge Test in Section 82 shall be installed in a pressurized beverage product system. There shall be no shutoff valve between the relief valve and any parts of the system under pressure.

9.2.3 Pressure relief devices in a pressurized product system shall be positioned, located, or baffled so that moisture discharged through the relief device will not wet uninsulated live parts.

9.2.4 A pressurized beverage product system shall comply with the tests in 81.6.

9.3 Mechanical protection

9.3.1 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of unintentional contact with moving parts and with hot surfaces that may cause injury to persons. See 9.3.4 and 9.3.5. Knockouts for entrance of electrical conduit and plumbing may be provided. In determining

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compliance with the requirements specified in 9.3.2 – 9.3.5, parts such as covers, panels, or grilles used as part of the enclosure are to be removed unless tools are required for their removal.

9.3.2 Moving parts, such as fan blades, shall be guarded or enclosed. Parts required for guarding shall be secured by means dependent upon tools for removal unless functioning of the water cooler requires the guard to be in place.

9.3.3 With reference to 9.3.2, moving parts are considered to be enclosed when the distance from an opening to the moving part is as specified in Table 9.1. For an opening having a minor dimension intermediate between two of the values included in the table, the distance from the opening to the moving part is determined by interpolation between the corresponding values in the right-hand column of the table. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22.3 N).

Exception No. 1: The following areas are considered to be solid surfaces for the purpose of applying this requirement:

a) The bottom of a freestanding unit.

b) The rear of a wall-hung unit.

c) The rear of an against-the-wall unit if, according to the instructions provided with the unit, no gap is allowed between the unit and the wall, and the unit has been tested accordingly.

Exception No. 2: A moving part is not to be considered if:

a) The part is unlikely to be contacted through the opening because of the location of fixed components, including baffles, water lines, drain tubes, and the like, or

b) The part is made inoperative, when exposed, through the use of interlocking devices.

If more than one method of routing plumbing lines is specified in the installation instructions, all methods are to be evaluated when determining if such lines, as installed, serve as baffles to prevent contact with moving parts.

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Table 9.1
Dimensions of openings

Minor dimensions of opening[a],		Minimum distance from opening to moving part[b],	
inches	(mm)	inches	(mm)
1/4	(6.4)	1/2	(12.7)
3/8	(9.5)	1-1/2	(38.1)
1/2	(12.7)	2-1/2	(63.5)
3/4	(19.1)	4-1/2	(114.0)
1	(25.4)	6-1/2	(165.0)

[a] Openings less than 1/4 inch (6.4 mm) are not to be considered. Openings greater than 1 inch (25.4 mm) shall be designed or located to reduce the risk of unintentional contact with moving parts that may involve injury to persons.

[b] Also applies to thermally hot parts. See Table 62.1.

9.3.4 When tested in accordance with the provisions of the Temperature and Pressure Test, Section 62, surfaces that exceed the temperature limit of Table 62.1 (d)(3) and (d)(4) shall be guarded in accordance with 9.3.2 and 9.3.3. In determining compliance with this requirement, the handle of the hot water spigot

on a hot- and cold-type water cooler is considered to be a surface contacted by persons in the operation of the unit, Table 62.1(d)(3). The hot water spigot itself is exempt from this requirement. Surfaces that are recessed or located away from the front of the water cooler are not considered subject to casual contact, see Table 62.1(d)(4). Examples of such surfaces include a condenser located at the rear of a freestanding unit and a compressor located over an opening in the bottom of a wall-hung unit.

9.3.5 The sheath of a heater element, as installed in a water cooler, shall be protected against mechanical damage. A copper or steel sheath at least 0.016 inch (0.41 mm) thick is considered to provide such protection. In addition, if the temperature of a heater exceeds the limits permitted by Table 62.1 (d)(3) or (d)(4), whichever is appropriate, it shall be guarded in accordance with 9.3.2 and 9.3.3 to protect persons from coming in contact with it.

9.4 Electrical protection

9.4.1 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of unintentional contact with uninsulated high-voltage live parts. Knockouts for entrance of electrical conduit and plumbing may be provided. To determine compliance with this requirement, parts such as covers, panels, or grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided. See 12.2.1.

9.4.2 Where an opening in the enclosure will not permit the entrance of a 3/4 inch (19.1 mm) diameter rod, the probe illustrated in Figure 9.1 shall not touch any uninsulated high-voltage live parts and the probe illustrated in Figure 9.2 shall not touch any film-coated wire when inserted through the opening. The probe shall not pass through grilles, screens, louvers, or the like when a force of 5 pounds (22.3 N) is applied.

Figure 9.1

Probes

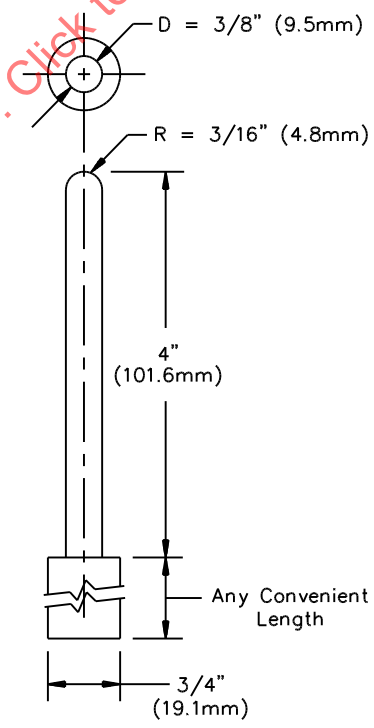

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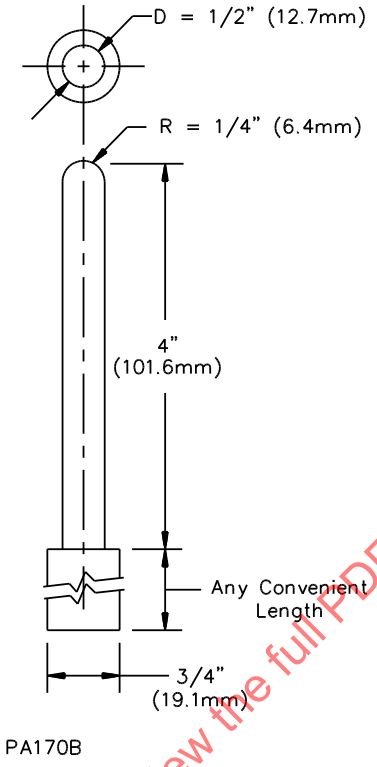
Figure 9.2

Probe



9.4.3 Where an opening in the enclosure permits the entrance of a 3/4 inch (19.1 mm) diameter rod, the conditions described in Figure 9.3 shall be used in determining compliance with the requirements. The minor dimension of the opening shall not exceed 1 inch (25.4 mm) in any case.

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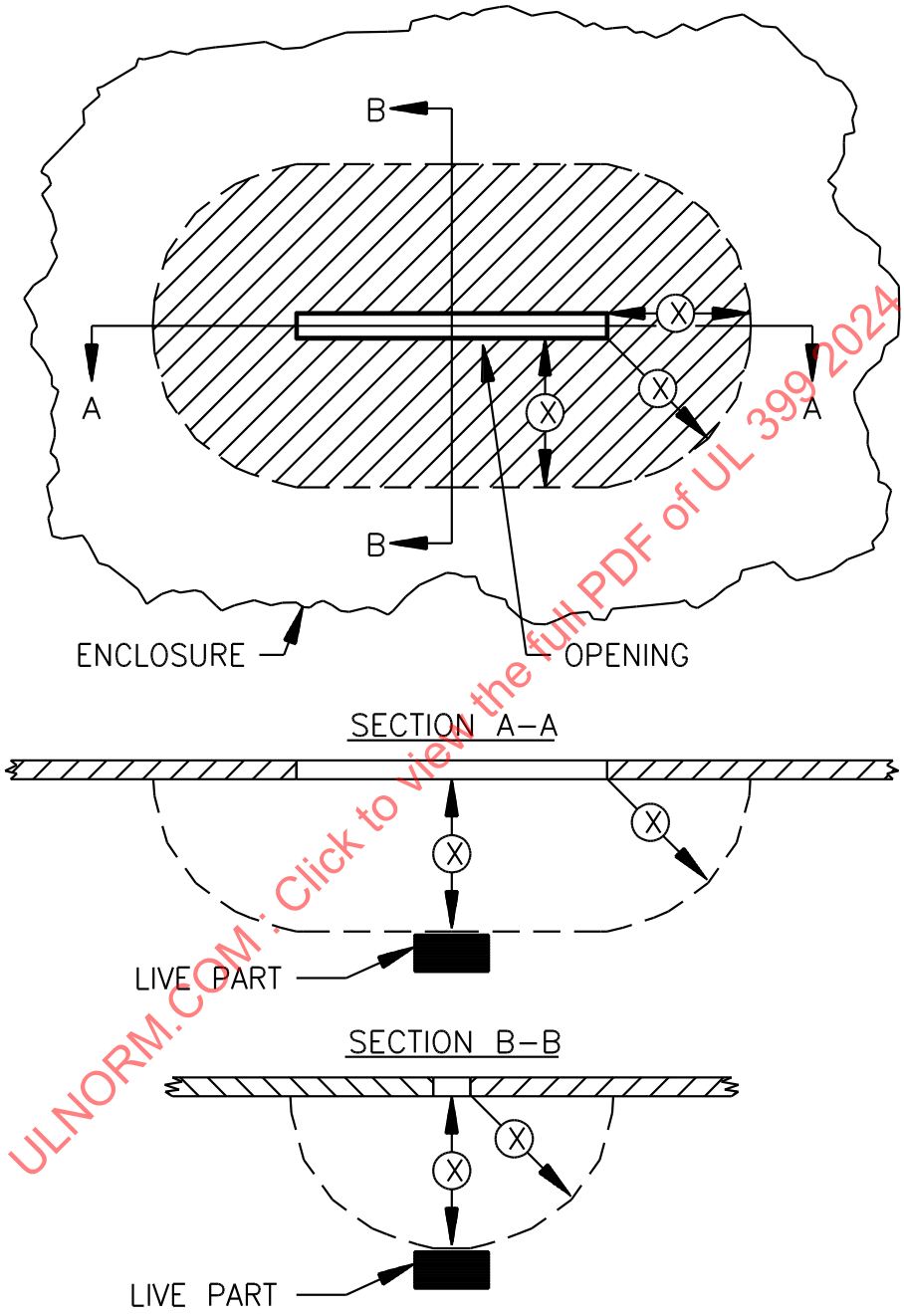
Figure 9.3

Opening in enclosure



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The opening is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire:

(1) less than X inches from the perimeter of the opening, as well as

(2) within the volume generated by projecting the perimeter X inches normal to its plane.

X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm).

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9.4.4 In addition to the requirements of 9.4.2 and 9.4.3, uninsulated high-voltage live parts inside the enclosure which are likely to be contacted by persons performing operations such as replacing fuses, resetting manual-reset devices, oiling motors, or other such normal service operations shall be located, guarded, or enclosed to reduce the risk of unintentional contact unless tools are required to expose the live part. See 97.13.

9.4.5 Electrical components shall be located or enclosed so that uninsulated high-voltage live parts will not be wetted by water due to condensation, splashing, or leakage.

9.4.6 On pressure type water coolers, a drain basin shall be constructed so that overflow due to a blocked drain will not wet uninsulated high-voltage live parts or film-coated wire.

9.4.7 A water reservoir on a bottle type water cooler and waste water receptacles on any type water cooler shall be constructed and located so that overflow will not wet uninsulated high-voltage live parts or film-coated wire.

9.4.8 The Overflow Test, Section 66, is to be conducted if it is not evident that the water cooler complies with the provisions of 9.4.6 and 9.4.7.

9.4.9 A bottle type water cooler shall be constructed so that a liquid spill on the top surface of the unit, during removal or installation of water containers will not wet uninsulated live parts or film-coated wire in line-voltage circuits. A Spill Test, Section 67, is to be conducted if it is not evident that the water cooler complies with this requirement.

9.4.10 A switch, attachment-plug receptacle, motor-attachment plug, or similar component shall be secured in position and, except as noted in 9.4.11, shall be prevented from turning. See 9.4.12.

9.4.11 The requirement that a switch be prevented from turning will be waived if the following conditions are met:

a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during the operation of the switch,

b) Means of mounting the switch make it unlikely that operation of the switch will loosen it,

c) The spacings are not reduced below the minimum required values if the switch rotates, and

d) Operation of the switch is by mechanical means rather than direct contact by persons.

9.4.12 With reference to 9.4.10, the means for preventing rotation is to consist of more than friction between surfaces. A toothed lock washer that provides both spring take-up and an interference lock is acceptable as means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

9.4.13 An uninsulated high-voltage live part and its support shall be secured to a mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values. See Spacings, High-Voltage Circuits, Section 46. Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part, but a lock washer as described in 9.4.12 is acceptable.

9.4.14 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated high-voltage live parts. See 78.2.1.

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10 Barriers

10.1 A barrier shall be secured to the mounting surface such that tools are required for its removal.

10.2 A barrier shall be formed from one or more of the following:

a) Metal, minimum 0.005 inch (0.13 mm) thick,

b) Fiberglass, minimum 0.5 inch (12.7 mm) thick,

c) A nonmetallic material rated 5VA,

d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in UL 746C,

e) Any other material or construction determined to be equivalent to items (a) to (d).

10.3 In reference to 10.2, a nonmetallic barrier exposed to UV radiation shall comply with 8.1.4.

10.4 In reference to 10.2, a rigid backing or a mechanical barrier shall be provided behind these materials unless the materials are determined to be suitably rigid.

10.5 A mechanical barrier shall be formed from one or more of the following:

a) Metal, minimum 0.026 inch (0.66 mm) thick,

b) A nonmetallic material which shall be considered a part of the cabinet and which shall comply with the cabinet requirements of Table 58.1,

c) Any other material or construction determined to be equivalent to (a) or (b).

11 Accessories

11.1 A water cooler having provisions for electrical accessories to be attached in the field shall be constructed so that the use of these accessories will not introduce a risk of fire, electric shock, or injury to persons.

11.2 The water cooler shall comply with all requirements of this standard with or without the accessory installed. Additional requirements for accessories are in 6.3 and 98.

11.3 Installation of accessories shall:

a) Be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors; and

b) Not require the cutting of wiring or the soldering of connections.

11.4 An accessory strain-relief means shall be provided for the wiring if there is a possibility of transmitting stress to the terminal connections during installation. The strain-relief shall comply with the Strain Relief Test in Section 72.

11.5 The accessory wiring connections shall be identified on both the accessory and on the water cooler.

11.6 The accessory mounting location shall be:

a) Identified on the water cooler; or

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b) Fixed due to the function of the accessory and its arrangement within the water cooler. In this case, the accessory installation instructions shall specify the mounting location of the accessory.

11.7 Accessories shall be trial-installed. The factors outlined below shall be considered when evaluating the trial-installation of the accessory:

a) Feasibility of the accessory installation;

b) Detailed and correct accessory installation instructions; and

c) The accessory installation complies with 11.1 to 11.6.

11.8 Accessories intended for connection to a source of field power supply independent of that of the equipment shall comply with the requirements in:

a) Section 13 if intended to be a permanently connected accessory. A permanently connected accessory shall not be used with any supply cord connected equipment.

b) Section 14 if intended to be a cord-connected accessory.

11.9 If an accessory is powered from a source of supply separate from that supplying the water cooler:

a) The water cooler power supply source shall not provide power to the same control box or electrical panel as the power source supplying the accessory and the water cooler shall be marked as specified in 98.3; or

b) Disconnection of any one supply shall automatically cause de-energization of all circuits within the water cooler and accessory(ies).

12 Enclosures

12.1 General

12.1.1 Enclosures shall be formed and assembled so that they will have the strength and rigidity necessary to resist the abuses to which they may be subjected without increasing the risk of fire or injury to persons due to total or partial collapse with the resulting reduction of spacings, loosening or displacement of parts, or other serious defects. Enclosures for individual electrical components, outer enclosures, and combinations of the two are considered in determining compliance with this requirement.

12.1.2 Among the factors that are taken into consideration when evaluating an enclosure are:

a) Mechanical strength,

b) Resistance to impact, and

c) Resistance to corrosion.

In addition to these factors, a nonmetallic enclosure or part of an enclosure is evaluated for:

a) Moisture-absorption properties,

b) Flammability, and

c) Resistance to distortion at temperatures to which the material may be subjected under conditions of use.

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For a nonmetallic enclosure or part of an enclosure, all of these factors are considered with respect to aging.

12.1.3 Additional flammability tests may be needed on nonmetallic outer enclosure materials if internal wiring is not enclosed by means such as conduit, electric metallic tubing, metal raceways or control boxes. See Internal Wiring and Wiring Methods, Section 15.

12.1.4 The electrical components within the cabinet, such as controls, solenoids, starting relays, motors and switches shall comply with one of the following:

a) Electrical components shall be enclosed, except for terminals,

b) The cabinet is arranged such that any failure of an electrical component shall not result in a risk of fire or emission of flame or molten metal, or

c) Electrical components other than switches or motors shall comply with the Burnout Test – Other Components, Section 75.3.

12.1.5 Compliance with 12.1.4 shall be based on the design and location of the components with respect to openings in the cabinet.

12.1.6 In reference to 12.1.5, openings in the bottom of the cabinet shall be arranged to prevent glowing or flaming particles from falling out of the cabinet.

12.1.7 Barriers used for compliance with 12.1.6 shall be horizontal and located as indicated in Figure 23.1 with respect to unenclosed electrical components located within the cabinet.

12.1.8 A built-in water cooler shall be constructed and assembled to reduce the risk of the emission of molten metal, burning insulation or flaming particles into the wall space or the area beneath the water cooler.

12.1.9 The requirement of 12.1.8 necessitates the use of totally enclosed fan motors and complete enclosures for controls, starting relays, capacitors, and other electrical components, including the wiring, unless these parts are installed in an overall enclosure provided with the built-in unit. Such an enclosure shall have:

a) No ventilating openings which will permit the entrance of a 3/8 inch (9.5 mm) diameter rod,

b) All ventilating openings located or provided with a barrier, baffle, or louver to reduce the risk of the expulsion of molten metal, burning insulation or flaming particles, and

c) A nonflammable solid bottom without openings. Knockouts for entrance of electrical conduit and plumbing may be provided.

12.1.10 A built-in water cooler shall have necessary ventilating grilles furnished with the water cooler.

12.1.11 A sheet metal cabinet or enclosure shall be evaluated with respect to its size, shape, metal thickness and use in the particular application. Except as specified in 12.1.11.1, a sheet metal cabinet or enclosure shall have a thickness of not less than:

a) 0.026 inch (0.66 mm) if uncoated steel;

b) 0.029 inch (0.74 mm) if coated (galvanized) steel; or

c) 0.036 inch (0.91 mm) if nonferrous metal.

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12.1.11.1 A sheet metal cabinet or enclosure thinner than that specified in 12.1.11 shall be subjected to the Cabinet/Enclosure Static Load Test in 70A and the Cabinet/Enclosure Impact Test in 70B unless a visual examination determines that the construction of the cabinet and/or enclosure would comply with these tests.

12.1.12 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) if uncoated steel, not less than 0.034 inch (0.86 mm) if galvanized steel, and not less than 0.045 inch (1.14 mm) if nonferrous.

12.1.13 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be not less than three nor more than five threads in the metal, and the construction of the device shall be such that a conduit bushing can be properly attached. If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall be not less than 3-1/2 threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and which shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

12.1.14 A knockout in a sheet metal enclosure shall be secured in place, but shall be capable of being removed without deformation of the enclosure that would result in damage to electrical components, reduction in electrical spacings, or both.

12.1.15 A knockout shall remain in place when a force of 10 pounds (44.5 N) is applied at right angles to the knockout by a 1/4 inch (6.4 mm) diameter mandrel with a flat end. The mandrel shall be applied at the point most likely to cause movement of the knockout.

12.1.16 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated high-voltage live parts and the bushing of less than those required by this standard.

12.1.17 In measuring a spacing between an uninsulated high-voltage live part and a bushing installed in a knockout, it is to be assumed that a bushing having the dimensions indicated in Table 12.1 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

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Table 12.1
Knockout or hole sizes and dimensions of bushings

Trade size of conduit,		Knockout or hole diameter,		Bushing dimensions			
				Overall diameter,		Height,	
inches	(mm O.D.)	inches	(mm)	inches	(mm)	inches	(mm)
1/2	(21.3)	7/8	(22.2)	1	(25.4)	3/8	(9.5)
3/4	(26.7)	1-3/32	(27.8)	1-15/64	(31.4)	27/64	(10.7)
1	(33.4)	1-23/64	(34.5)	1-19/32	(40.5)	33/64	(13.1)

12.1.18 Steel enclosures shall be protected against corrosion by metallic or nonmetallic coatings such as plating or painting. See 12.3.1 – 12.3.6.

12.2 Doors and covers

12.2.1 Service covers or panels in the outer enclosure shall require the use of tools for removal or shall be provided with an interlocking mechanism if they give access to unenclosed uninsulated high-voltage live parts, moving parts, or UV radiation.

12.2.2 An interlocking mechanism as referenced in 12.2.1 shall comply with 21.13 – 21.18 and shall:

a) Be engaged with the cover in the closed position before parts are energized,

b) Secure the cover in the closed position when engaged.

12.2.3 A hinged or pivoted panel or cover shall be positioned or arranged so that when it is in an open position to facilitate servicing, it is not subject to falling or swinging due to gravity or vibration so as to cause injury to persons from the panel or cover, from moving parts or from uninsulated high-voltage live parts.

12.2.4 The assembly shall be arranged so that an overcurrent protective device, such as a fuse, can be replaced and manual-reset devices can be reset without removing parts other than a service cover(s) or panel(s), and the cover or door enclosing the device.

12.2.5 A required protective device shall not be accessible from outside the enclosure without opening a door or cover.

Exception: The operating handle of a circuit breaker, the reset button of a manually resettable motor protector, the reset button of a manually resettable pressure switch, and similar parts may project outside the enclosure.

12.2.6 An opening in an outer enclosure around a handle, reset button, or other control member is acceptable if the clearance between the control member and the edge of the opening is not more than 1/8 inch (3.2 mm) for any setting or position of the control member.

12.2.7 Covers for enclosures of fuses in high-voltage circuits shall be hinged. Covers for manual-reset overload protective device enclosures shall be hinged if it is necessary to open the cover to reset the device.

Exception: A hinged cover is not required where the only fuses enclosed are:

a) Supplementary type control circuit fuses, provided the fuses and control circuit loads, other than a fixed control circuit load such as a pilot lamp, are within the same enclosure, or

b) Supplementary type fuses of 2 amperes or less for small auxiliary resistance heaters, such as crankcase heaters, with a maximum rating of 100 watts (W),

c) An extractor-type fuse with its own enclosure, or

d) Fuses in low-voltage circuits.

12.2.8 Hinged covers, where required, shall not depend solely upon screws or other similar means to hold them closed, but shall be provided with a latch or the equivalent.

12.2.9 A spring latch, magnetic latch, dimple, or any other mechanical arrangement that will hold the door in place and will require some effort on the user's part to open it is considered to be a means for holding the door in place as required in 12.2.8. When provided as the sole means for securing the cover or panel, a cover interlocking mechanism as described in 12.2.2 is considered to comply with 12.2.8.

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12.2.10 A door or cover giving direct access to fuses in other than low-voltage circuits shall shut closely against a 1/4 inch (6.4 mm) rabbet or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A special construction, such as a fuse enclosure, located within an outer enclosure, or a flange and rabbet combination which affords the equivalent protection is acceptable.

12.2.11 Strips used to provide rabbets, or angle strips fastened to the edges of a door, shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings, not more than 6 inches (152.4 mm) apart.

12.3 Enclosures exposed to weather

12.3.1 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion as specified in Table 12.2 or by other metallic or nonmetallic coatings which provide equivalent protection.

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Table 12.2
Protection against corrosion

Type of cabinet and enclosure	0.053 inch (1.35 mm) and heavier as specified by paragraph	Lighter than 0.053 inch (1.35 mm) as specified by paragraph
Outer cabinets which protect motors, wiring, or enclosed current carrying parts	12.3.3	12.3.4
Inner enclosures which protect current carrying parts other than motors	12.3.3	12.3.4
Outer cabinets which are the sole enclosure of current carrying parts	12.3.4	12.3.4

12.3.2 12.3.1 is not applicable to a metal part, such as a decorative grill, which is not required for conformance with this standard.

12.3.3 To comply with 12.3.1, one of the following coatings shall be used:

a) Hot-dipped, mill-galvanized sheet steel conforming with the Coating Designation G60 or A60 in Table 1 of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated Galvanealed by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in the ASTM Specification. The weight of zinc coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron or Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90. An A60 (alloyed) coating shall also comply with 12.3.5.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 88. An annealed coating shall also comply with 12.3.5.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The corrosion protective coating shall comply with the Salt-Spray (Fog) Test and Moist Carbon Dioxide-Air Test described in the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

12.3.4 To comply with 12.3.1, one of the following coatings shall be used:

a) Hot-dipped, mill-galvanized sheet steel conforming with the Coating Designation G90 in Table 1 of ASTM/A653-M with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirements in the ASTM Specification. The weight of zinc coating shall be established in accordance with the Test Method of ASTM A90.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 88. An annealed coating shall also comply with 12.3.5.

c) A cadmium coating of not less than 0.001 inch (0.025 mm) in thickness on both surfaces. The thickness of coating shall be established by the Metallic Coating Thickness Test, Section 88.

d) A zinc coating conforming with 12.3.3 (a) or (b) with one coat of outdoor paint as specified in 12.3.3(c).

e) A cadmium coating of not less than 0.00075 inch (0.0191 mm) in thickness on both surfaces with one coat of outdoor paint on both surfaces or of not less than 0.0005 inch (0.013 mm) in thickness on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the Metallic Coating Thickness Test, Section 88, and the paint shall be as specified in 12.3.3(c).

12.3.5 An annealed zinc coating which is bent or similarly formed after annealing shall additionally be painted in the bent or formed area if the bending or forming process damages the zinc coating. If flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered damaged. Simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes are to conform with this requirement.

12.3.6 With reference to 12.3.1, other finishes, including paints, special metallic finishes, and combinations of the two, may be accepted when comparative tests with galvanized sheet steel without annealing, wiping, or other surface treatment conforming with 12.3.3(a) or 12.3.4(a), as applicable, indicate they provide equivalent protection. Among the factors which are taken into consideration when judging the suitability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

12.3.7 Nonferrous enclosures may be employed without special corrosion protection. See 12.1.2.

12.3.8 If gaskets are required to seal electrical enclosures against the entrance of rain and condensate, they shall comply with 86.2 – 86.5 or with the Standard for Gaskets and Seals, UL 157 if the gasket physical properties are equivalent to those specified in 86.2 – 86.5. In addition, each gasket shall:

a) Be held in place by mechanical fasteners or adhesives, except as indicated in 12.3.11; and

b) Be neoprene, rubber, thermoplastic or other materials with equivalent properties.

12.3.9 Sealing compounds required to seal electrical enclosures shall comply with 86.6.

12.3.10 Adhesives required to secure gaskets shall comply with 86.7.

12.3.11 In reference to 12.3.8(a), gaskets which are not held in place by mechanical fasteners or adhesives but are intended to be retained in the correct position by some other means shall be prevented from displacement either:

a) Due to their location within the equipment; or

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b) By the placement of other components in the enclosure so that if the equipment cover is removed, the gasket will be reengaged in the intended manner when the cover is replaced.

13 Field Supply Connections for Permanently Connected Water Coolers

13.1 General

13.1.1 Water coolers of the following types shall have provision for permanent connection to the power supply in accordance with the National Electrical Code, ANSI/NFPA 70:

a) Any remote or built-in type.

b) Any unit which has a total marked rating exceeding a 16-ampere load.

c) Any unit rated in excess of 250 volts.

d) All polyphase units.

13.1.2 With reference to 13.1.1(b), the largest sum of concurrent loads shown on the nameplate shall be used to determine the total marked rating.

13.1.3 As used in Terminals (10.1A) and Leads (10.1B), field-wiring connections are considered to be the terminals or leads to which power supply, control, or equipment grounding connections will be made in the field when the water cooler is installed.

13.1.4 A knockout for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 13.1.

Table 13.1
Trade size of conduit (mm O.D.)

Wire size,		Number of wires, inches (mm OD)									
AWG	(mm^2)	2		3		4		5		6	
14	(2.1)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	(3.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
10	(5.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
8	(8.4)	3/4	(26.7)	3/4	(26.7)	3/4	(26.7)	1	(33.4)	1	(33.4)

NOTE – This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved of if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

13.1.5 The location of a terminal box or compartment in which power supply connections are to be made shall be such that these connections may be inspected after the water cooler is installed. The connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

13.1.6 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be prevented from turning.

13.1.7 The water cooler shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity of not less than that indicated in 99.11.It is assumed that branch circuit conductors rated 140°F (60°C) will be used.

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13.2 Terminals

13.2.1 For field-wiring terminals intended for 8 AWG (8.4 mm^2) and larger conductors, pressure wire connectors shall be used. For field-wiring terminals intended for 10 AWG (5.3 mm^2) and smaller conductors, the parts to which wiring connections are made may consist of clamps or wire binding screws with cupped washers, terminal plates, or the equivalent to hold the wire in position.

13.2.2 Size 14 AWG (2.1 mm^2) wire shall be considered as being the smallest wire that can be used for branch circuit wiring and at a terminal intended for the connection of the power supply leads.

13.2.3 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 13.1.7 and 99.11, but no smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

13.2.4 Wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with 13.2.5 – 13.2.10 or with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

13.2.5 A field-wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by such means as two screws or rivets; by square shoulders or mortises; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part.

13.2.6 A wire binding screw at a field-wiring terminal shall not be smaller than 8 AWG (4.2 mm diameter), except that a 6 AWG (3.5 mm diameter) screw may be used for the connection of one 14, 16, or 18 AWG (2.1, 1.3, or 0.82 mm^2) conductor.

13.2.7 A terminal plate for a wire binding screw shall be of metal not less than 0.030 inch (0.76 mm) in thickness for a 14 AWG (2.1 mm^2) or smaller wire and not less than 0.050 inch (1.27 mm) in thickness for a wire larger than 14 AWG, and in either case there shall be not less than two full threads in the metal.

13.2.8 A terminal plate formed from stock having the minimum required thickness may have the metal extruded at the tapped hole for the binding screw to provide two full threads, except that two full threads are not required if a lesser number of threads results in a connection in which the threads will not strip with normal tightening torque in accordance with the values indicated in the Standard for Wire Connectors, UL 486A-486B.

13.2.9 A wire binding screw shall thread into metal.

13.2.10 A field-wiring terminal intended for the connection of a grounded conductor shall be of a metal or plated with a metal distinguishable from the other terminals, or proper identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram.

13.3 Leads

13.3.1 Leads intended for connection to any external high-voltage circuit or to an external extra-low-voltage circuit that contain one or more of the components specified in 47.3 shall comply with all of the following:

a) Be one of the types of wiring specified in 15.2;

b) Be 6 inches (152 mm) or more in length, as measured from the lead end to the strain relief means, unless the use of a shorter lead is required to prevent damage to the lead insulation;

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c) Be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. Leads shall comply with 72.1 when subjected to a direct pull of 20 pounds-force (89 N);

d) Not be connected to wire binding screws or pressure wire connectors located in the same compartment as the lead ends (that are intended for spliced connections to the field-wiring) unless the screws or connectors are rendered unusable for field-wiring connections or the lead ends are insulated; and

e) Be insulated at the free end, if the lead will not be used in every installation and if the end can reduce spacings below the minimum acceptable values specified in Section 46 for high-voltage circuits or Section 47 for extra-low-voltage circuits.

13.3.2 A lead intended for the connection of a grounded conductor shall be finished to show a white or gray color, shall be distinguishable from other leads, and no other lead shall be so identified.

13.4 Grounding

13.4.1 A water cooler shall be provided with an equipment grounding terminal or lead.

13.4.2 A terminal solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the size required for the particular application in accordance with the National Electrical Code, NFPA 70.

13.4.3 A soldering lug, a push-in connector, a screwless connector, or a quick connect or similar friction fit connector shall not be used for a grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord.

13.4.4 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. Except as indicated in 13.4.5, 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 (from IEC 60417, Symbol 5019) as illustrated in Figure 13.1, or by a marking on a wiring diagram provided on the water cooler. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the water cooler and shall be located so that it is unlikely to be removed during normal service operations such as replacing fuses, resetting manual-reset devices, or oiling motors.

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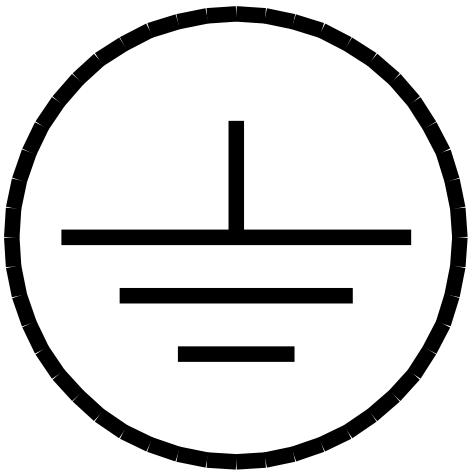
Figure 13.1

Grounding symbol



13.4.5 If a pressure wire connector intended for grounding is located where it could be mistaken for the neutral conductor of a grounded supply, it shall be identified by a marking EQUIPMENT GROUND and/or with a green color identification.

13.4.6 The surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

14 Supply Connections – Cord Connected Equipment

14.1 Equipment intended for cord connection to the supply shall be provided with:

a) A non-detachable power supply cord for connection to the supply by means of a plug, or

b) An appliance coupler and inlet (motor attachment plug) for connection of a detachable power supply cord and either a detachable power supply cord or instructions for selection of a suitable detachable power supply cord.

14.2 In reference to 14.1, a power supply cord and plug or appliance coupler shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817. An inlet shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

14.3 The marked rating of a cord connected water cooler, see 100.1, shall not exceed 80 percent of the rating of the attachment plug.

14.4 Except as indicated in 14.5 or 14.13, a cord-connected water cooler shall employ a grounding-type attachment-plug that complies with the ANSI designation as specified in Table 14.1 based on the water cooler voltage and ampere rating.

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Table 14.1
Attachment plugs

Nameplate rating			Attachment plug	
Volts	Phase	Amperes[a]	Rating	ANSI designation[b]
110 – 120	1	12.0	15 amperes, 125 volts	5-15P
110 – 120	1	16.0	20 amperes, 125 volts	5-20P
110 – 120	1	24.0	30 amperes, 125 volts	5-30P
110 – 120	1	40.0	50 amperes, 125 volts	5-50P
200 – 240	1	12.0	15 amperes, 250 volts	6-15P
200 – 240	1	16.0	20 amperes, 250 volts	6-20P
200 – 240	1	24.0	30 amperes, 250 volts[c]	6-30P
200 – 240	1	40.0	50 amperes, 250 volts[c]	6-50P
110 – 120/200 – 240	1	12.0	15 amperes, 125/250 volts	14-15P
110 – 120/200 – 240	1	16.0	20 amperes, 125/250 volts	14-20P
110 – 120/200 – 240	1	24.0	30 amperes, 125/250 volts[c]	14-30P
110 – 120/200 – 240	1	40.0	50 amperes, 125/250 volts[c]	14-50P
200 – 240	3	12.0	15 amperes, 250 volts	15-15P
200 – 240	3	16.0	20 amperes, 250 volts	15-20P
200 – 240	3	24.0	30 amperes, 250 volts[c]	15-30P
200 – 240	3	40.0	50 amperes, 250 volts[c]	15-50P

[a] The maximum ampere rating for the attachment plug is indicated. The maximum ampere rating for the attachment plug is the maximum value to be marked on the unit nameplate. See 14.3.

[b] Standard for Wiring Devices – Dimensional Requirements, NEMA WD6.

[c] 30 and 50 ampere attachment plugs are for units intended to be moved for cleaning.

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14.5 In reference to 14.4, if the grounding-type attachment plug does not comply with the ANSI designation specified in Table 14.1, then the equipment shall be rated 250 volts or less and shall be intended for connection to circuits rated for other than:

a) 60 Hz and/or

b) The voltages specified in the first column of Table 59.1.

14.6 A cord connected water cooler shall employ a Type S, SO, ST, STO, SJ, SJO, SJT, SJTO, SP-3, or SPT-3 power supply cord rated for use at a voltage not less than the rated voltage of the water cooler. The ampacity of the cord as given in the National Electrical Code, NFPA 70, shall be not less than that required by the ampere input measured in the Temperature and Pressure Test, Section 62.

14.7 A power supply cord for an outdoor-use water cooler shall be one of the types specified in 14.6 and identified by the letter “W” following the cord type designation marked on the jacket.

14.8 The length of the power supply cord shall be not more than 10 feet nor less than the lengths indicated below.

a) Not less than 3 feet (0.91 m) for counter-supported bottle-type water coolers.

b) Not less than 6 feet (1.83 m) for bottle-type water coolers other than those specified in (a).

c) Not less than 1-1/2 feet (457 mm) for wall-hung, pressure-type water coolers.

d) Not less than 4 feet (1.22 m) for freestanding, pressure-type water coolers.

The length is measured between the attachment plug and any point at which the cord exits the water cooler cabinet or the last strain relief, whichever is shorter.

14.9 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. The strain relief means shall comply with 72.1 when subjected to a direct pull of 35 pounds-force (156 N).

14.10 Moving a power supply cord inward shall not result in either:

a) Cord damage, or

b) A metallic strain relief being able to contact uninsulated live parts. Spacings in accordance with Sections 46 or 47 shall be maintained.

14.11 The edges of the entry hole for the power supply cord, including the cord entry hole in a bushing, shall be smooth and rounded without burrs, fins, or sharp edges which might damage the cord insulation. The power supply cord shall be routed to prevent damage to the cord insulation.

14.12 Except as specified in 14.14, the power supply cord shall be provided with an equipment grounding conductor terminating within the equipment. The supply cord equipment grounding conductor shall be:

a) Finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified;

b) Secured to the frame or enclosure of the equipment by a positive means that is not likely to be removed during any servicing operation not involving the power supply cord. A sheet metal screw or quick-connect terminal shall not be used; and

c) Connected to the grounding blade of the attachment plug.

14.13 A water cooler not complying with 14.4 and 14.12 but provided with a polarized plug shall be thermoelectric and double insulated. The large blade shall be connected to the grounded conductor of the water cooler. If the supply cord is detachable, the connection shall not be reversible. No grounding means shall be provided.

14.14 In reference to 14.13, if a polarized plug is provided on a cord-connected thermoelectric water cooler, then all of the high-voltage components and wiring shall comply with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097. In addition, the water cooler shall be:

a) Rated less than 12 amperes; and

b) Intended for connection to a supply source rated no higher than 120V.

14.15 A cord connected water cooler and any intended accessory(ies) provided with more than one power supply cord shall comply with all of the following:

a) The equipment shall consist of two separate units joined together;

b) Not more than two cords shall be provided;

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c) Each cord shall be of the type and rating specified in 14.6 and provided with an equipment grounding conductor in accordance with 14.12;

d) Each attachment plug shall be as specified in 14.3 – 14.5;

f) The markings specified in 100.4 (a) and (c) shall be provided; and,

g) The instructions shall contain the information specified in 6.8.

14.16 In reference to 14.15, if the combined rated current input to both supply cords exceeds 80 percent of the branch circuit to which the equipment will be connected, then the unit or cord with the highest rated current input shall be marked adjacent to the supply cord in accordance with 100.4(b).

15 Internal Wiring And Wiring Methods

15.1 Wiring shall have insulation rated for the potential involved and the temperatures to which it may be subjected. Compliance shall be determined in accordance with any of the following:

a) Wiring temperatures shall be judged on the basis of the temperatures measured during the applicable temperature test specified in 62.1,

b) Other than motor wiring, all wiring shall:

1) Have an ampacity of the conductors in accordance with Table 15.2, and

2) Not be exposed to heat from radiating sources or heated components.

c) Motor wiring shall have an ampacity not less than 125 percent of the motor full load or maximum operating current rating in addition to complying with (b).

15.2 Wiring shall comply with one of the following:

a) Standard for Appliance Wiring Material, UL 758;

b) Standard for Thermoset-Insulated Wires and Cables, UL 44;

c) Standard for Flexible Cords and Cables, UL 62; or

d) Standard for Thermoplastic-Insulated Wires and Cables, UL 83

15.3 Wire positioning devices shall comply with the Standard for Positioning Devices, UL 1565.

15.4 Wiring which is color coded green or green with one or more yellow stripes shall be used only for grounding conductors. Wiring used for other purposes shall not be identified with the above color codes.

15.5 Wires or cords connected to fan motors and other auxiliary motors shall employ oil resistant insulation, such as Type SJO, SJT, SPT-3, or appliance wiring materials having oil resistant insulation.

15.6 Parallel conductor appliance wiring material of the integral type shall not be ripped more than 3 inches (76.2 mm) unless the minimum wall thickness of the conductor insulation after ripping is at least 0.058 inch (1.47 mm) in thickness. If the material has conductor insulation not less than 0.028 inch (0.71 mm) after ripping and is within a separate metal enclosure, conduit, electrical metallic tubing, or metal raceway, the length of rip is not limited.

15.7 If any failure of low-voltage wiring may cause malfunctioning of a pressure-limiting device, motor overload protective device, or other protective device, such wiring shall be:

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a) Enclosed as indicated in 15.18,

b) Types SPT-2 or SP-2 cord, or

c) One of the types indicated in Group B or C of Table 15.1.

Wires of types specified in Group A of Table 15.1 or low-energy safety control wire may be used if such wiring is located in a cavity or compartment of the water cooler and is shielded from damage.

Table 15.1
Typical wiring materials

Group	Type of wire, cord, or cable	Wire size, AWG	Wire size, (mm^2)	Insulation thickness, inch	Insulation thickness, (mm)
A	ACHH, ACTH, ACT, RFH-2, RFHH-2, FF-2, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RHH, RHW, THW, XHHW, MTW, THWN, PF, PGF, PFF, PGFF, TW, or thermoplastic appliance wiring material, with insulation thicknesses shown at the right corresponding to wire sizes indicated	10 and smaller	(5.3)	2/64	(0.8)
		8	(8.4)	3/64	(1.2)
B	SO, ST, SPT-3, SJO, SJT, or appliance wiring material[a] having thermoplastic or neoprene insulation with insulation thicknesses shown at right corresponding to the wire sizes indicated	18	(0.82)	4/64	(1.6)
		16	(1.3)	4/64	(1.6)
		14	(2.1)	5/64	(2.0)
		12	(3.3)	5/64	(2.0)
		10	(5.3)	5/64	(2.0)
		8	(8.4)	6/64	(2.4)
C	S, SJ, SP-3, or appliance wiring material[a] with rubber insulation	Same as group B			

[a]Appliance wiring material recognized for refrigeration use.

Table 15.2
Wiring material ampacities

Wire size		
mm^2	AWG	Ampacity
0.41	22	4
0.66	20	7
0.82	18	10
1.3	16	13
2.1	14	18
3.3	12	25
5.3	10	30
8.4	8	40
13.3	6	55
21.2	4	70
33.6	2	95
42.4	1	110

Table 15.2 Continued on Next Page

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Table 15.2 Continued

Wire size		
mm^2	AWG	Ampacity
Note – The ampacities shown apply to appliance wiring materials with insulation rated not less than 90°C (194°F). For types of wires other than appliance wiring materials, the ampacity shall be determined from Tables 1 through 4 and Table 12 in the Canadian Electrical Code, Part I, CSA Standard C22.1 and Tables 310-16 and 310-17 in the National Electrical Code, ANSI/NFPA No. 70, for the type of wire employed. The correction factors of the referenced tables need not be applied.		

15.8 All wires and cords used in a water cooler shall be routed and supported to prevent damage due to:

a) Sharp edges,

b) Surfaces and parts which operate at temperatures in excess of that for which the wire insulation is rated,

c) Moving parts, and

d) Parts which can be expected to vibrate such as motors, motor-compressors, refrigerant lines, and the like.

Clamping means are to have smooth, rounded surfaces.

Exception: Wires and cords may contact a vibrating part provided:

a) The wiring is securely fastened to the part at the point of contact so as to restrict movement,

b) The part does not have burrs, fins, or sharp edges which might abrade the insulation, and

c) Vibration does not place a strain on the wiring or wiring connections.

15.9 A wiring enclosure shall provide a smooth wireway with no sharp edges or projecting screws which might damage the insulation.

15.10 To prevent abrasion of insulation, holes for passage of wires or cords through walls, panels, or barriers shall have one of the following:

a) Smooth, rounded surfaces;

b) Smoothly rounded bushings fabricated from materials such as ceramic, phenolic, cold-molded composition, or fiber; or

c) Wire insulating bushings that comply with the Standard for Insulating Bushings, UL 635.

15.11 All wires and cords shall be routed and supported so that they will not be immersed in water unless the insulation is specifically intended for this purpose.

15.11.1 Water caused by condensation or rain exposure (for products intended for outdoor use) shall not enter wiring and electrical enclosures unless:

a) The point of water entrance is not in proximity to live electrical parts; and,

b) Live parts are not wetted.

15.12 All splices and connections shall be mechanically secured and electrically bonded. A soldered connection shall be made mechanically secure before being soldered.

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15.13 Splices shall be located within the water cooler enclosure. They shall be secured in position or located in a separate enclosure so that they are not subject to flexing, motion or vibration due to air movement, or the like. Strain relief shall be provided on the conductors if the wiring is liable to be moved during normal service operation, such as replacing fuses, resetting manual-reset devices, or oiling motors.

15.14 A splice shall be provided with electrical insulation equivalent to that of the conductors if permanence of spacing between the splice and other metal parts is not assured. Thermoplastic tape wrapped over a sharp edge is not acceptable.

15.15 Splicing devices, such as wire connectors, shall comply with the Standard for Wire Connectors, UL 486A-486B or the Standard for Splicing Wire Connectors, UL 486C.

15.16 Quick connecting assemblies shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310, form a secure electrical connection, and be capable of carrying the current involved.

15.17 Wire binding screws shall thread into metal. At terminals, stranded conductors shall be secured by soldered or pressure-type terminal connectors, or the conductors shall be soldered or otherwise assembled to prevent loose strands after assembly. Soldered connections shall be made mechanically secure before being soldered. Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means. The shanks of terminal connectors shall be protected by electrical insulation if the spacings may be reduced below the minimum acceptable values by slight loosening of the clamping means. The insulating material shall be secured in position. The thickness of the insulation on the shanks shall be not less than 0.028 inch (0.71 mm) except as permitted by 46.9.

15.18 Wiring shall be of the types indicated in Table 15.1, as follows:

a) Group A or B, or

b) Group C if the compartment enclosing the wiring:

1) Contains no openings other than for conduit or piping, and

2) Contains no flammable material other than electrical insulation.

15.19 Wiring not enclosed by means of conduit, electrical metallic tubing, metal raceways, or enclosures shall be enclosed according to 15.20 – 15.26.

15.20 No openings shall be located in the top of the compartment unless barriers or baffles are placed between the wiring and the openings.

15.21 No openings shall be located in the bottom of the compartment unless a U-shaped channel or trough is located under the wiring.

15.22 Louvers or openings located on the sides and top of the assembly shall not permit entrance of a 1/2 inch (12.7 mm) diameter rod.

15.23 Openings shall not be located closer than 1/4 inch (6.4 mm) to the wiring unless barriers or baffles are placed between the wiring and the openings.

15.24 Other than electrical insulation, wiring shall be separated from HB and HBF materials in accordance with 8.2.1, 8.2.2, or 8.2.3.

15.25 In reference to 15.21, wires shall not project through the plane of the top of the trough or channel.

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15.26 Group A wiring shall be cabled, routed, located or secured to reduce the risk of damage to the wiring when replacing fuses, adjusting control settings and other similar servicing.

15.27 Conductors of motor circuits having two or more thermal- or overcurrent-protected motors wired for connection to one supply line shall comply with one or more of the following:

a) A conductor shall have an ampacity of not less than one-third the ampacity of the branch circuit conductors as determined in 13.1.7,

b) A conductor shall be:

1) Size 18 AWG (0.82 mm^2) or larger,

2) Not more than 4 feet (1.2 m) in length, and

3) Protected by a fuse or equivalent overcurrent protective device rated not more than 60 amperes.

c) A conductor shall serve as a jumper lead between controls and shall:

1) Not exceed 3 inches (76.2 mm) in length; or

2) Be located in an electrical control enclosure.

d) A conductor shall withstand the Limited Short-Circuit Test, Section 79.

16 Separation of Circuits

16.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of different circuits, for example, internal wiring including wires in a wiring compartment, shall be separated by barriers or shall be segregated, and shall, in any case, be separated or segregated from uninsulated live parts connected to different circuits. Segregation of insulated conductors may be accomplished by clamping, routing, or other means that provides permanent separation from insulated or uninsulated live parts of a different circuit.

16.2 Field-installed conductors of any circuit shall be segregated or separated by barriers from field-installed and factory-installed conductors connected to any other circuit unless the conductors of both circuits are, or will be, insulated for the maximum voltage of either circuit.

16.3 Field-installed conductors of a high-voltage circuit or of an extra-low-voltage circuit that is provided with a protective control shall be segregated or separated by barriers to reduce the risk of short circuiting or grounding as follows:

a) From uninsulated live parts connected to a different circuit, and

b) From any uninsulated live parts of a protective control.

16.4 Field-installed conductors of a low-voltage circuit with Class 2 National Electrical Code, NFPA 70, wiring shall be segregated or separated by barriers as follows:

a) From uninsulated live parts connected to a high-voltage circuit, and

b) From wiring terminals and any other uninsulated live parts of low-voltage electrical components, such as a pressure-limiting device, motor overload protective device, or other protective device, where short-circuiting or grounding may result in a risk of fire, electric shock, or injury to persons.

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16.5 If a barrier is used to provide separation between the wiring of different circuits, it shall be of metal or of a rigid insulating material secured in place.

17 Bonding for Grounding

17.1 Except as specified in 17.2, a water cooler shall have provision for the grounding of all exposed or accessible noncurrent carrying metal parts which are likely to become energized and which may be contacted by the user or by service personnel during service operations which are likely to be performed when the water cooler is energized.

17.2 Metal parts not complying with 17.1 shall be one of the following:

a) Adhesive-attached, metal-foil markings, screws, handles, and the like, that are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts to reduce the risk that they will become energized;

b) Isolated metal parts, such as motor controller magnet frames and armatures or small assembly screws, that are separated from wiring and uninsulated live parts;

c) Cabinets, panels, and covers that do not enclose uninsulated live parts if wiring is separated from the cabinet, panel, or cover to reduce the risk that it will become energized; or

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar materials not less than 1/32 inch (0.8 mm) in thickness, 0.028 inch (0.71 mm) minimum, and secured in place.

17.3 Metal-to-metal hinge bearing members for a door or cover are considered to be acceptable means for bonding a door or cover for grounding if a multiple-bearing pin-type hinge(s) is employed.

17.4 A separate component bonding conductor shall be of copper, a copper alloy, or other material suitable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings such as enameling, galvanizing, or plating. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage or be located within the confines of the outer enclosure or frame, and

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

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17.5 The bonding shall be by a positive means such as clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point greater than 455°C (850°F). The bonding connection shall penetrate nonconductive coatings such as paint or vitrous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material except as indicated in 17.8.

17.6 With reference to 17.5, a bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

17.7 An internal connection for bonding internal parts to the enclosure for grounding may employ a quick connect terminal of the specified dimensions provided the connector is not likely to be displaced and

provided the component is limited to use on a circuit having a branch circuit protective device rated as specified in Table 17.1.

Table 17.1
Bonding wire conductor size

Rating of overcurrent device, amperes	Size of bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)

[a] Or equivalent cross-sectional area.

17.8 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be acceptable if it complies with the provisions of the Current Overload Test – Bonding Conductors and Connections, Section 77, and the Limited Short-Circuit Test, Section 79, under any normal degree of compression permitted by a variable clamping device and also following exposure to the effects of oil, grease, moisture, and thermal degradation which may occur in service. Also, the effect of assembling and disassembling, for maintenance purposes, such a clamping device is to be considered with particular emphasis on the likelihood of the clamping device being reassembled in its intended fashion.

17.9 On a cord connected water cooler, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord except as permitted by 17.12 and 17.13.

17.10 On a permanently connected water cooler, the size of a conductor employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. Except as indicated in 17.12 and 17.13, the size of the conductor or strap shall be in accordance with Table 17.2.

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Table 17.2
Internal terminal connections for bonding

Terminal dimensions,		Rating of protective device,
inches	(mm)	amperes
0.020 by 0.187 by 0.250	(0.51 by 4.75 by 6.4)	20 or less
0.032 by 0.187 by 0.250	(0.81 by 4.75 by 6.4)	20 or less
0.032 by 0.205 by 0.250	(0.81 by 5.2 by 6.4)	20 or less
0.032 by 0.250 by 0.312	(0.81 by 6.4 by 7.9)	60 or less

17.11 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 17.10, is considered acceptable provided the minimum cross-sectional conducting area is equivalent to the wire sizes indicated in Table 17.2.

17.12 A smaller conductor may be used if the bonding conductor and connection comply with the provisions of the Current Overload Test – Bonding Conductors and Connections, Section 77, and the Limited Short-Circuit Test, Section 79.

17.13 A bonding conductor to a motor or other electrical component need not be larger than the size of the motor-circuit conductors or the size of the conductors supplying the component.

17.14 Splices shall not be employed in wire conductors used to bond electrical enclosures, motor frames, or other electrical components.

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

17.16 Functional grounding shall not be relied upon for equipment grounding or bonding.

18 Button or Coin Cell Batteries

18.1 A product, or any accessory of the product such as a wireless control, intended for use with one or more single cell batteries shall comply with 18.2 if the batteries are sized with a maximum:

a) Diameter of 1.25 inches (32 mm); and

b) Height that is less than its diameter.

18.2 A product for household use and provided with one or more batteries as specified in 18.1 shall comply with the Standard for Products Incorporating Button Batteries or Coin Cell Batteries, UL 4200A or be intended for one of the following:

a) Countertop use only;

b) Built-in, column mount or wall-hung installation and with the batteries located at a height not less than 4 feet (1.2 m) above the floor; or

c) Use where the batteries are not intended to be replaced and are not referenced in the product markings or in any instructions provided with the product.

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ELECTRICAL COMPONENTS

19 Current-Carrying Parts

19.1 All current-carrying parts of a water cooler shall be of silver, copper, a copper alloy, or other corrosion resistant material.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not comply with this requirement.

19.2 Aluminum may be used as a current-carrying part if investigated and found to be treated to resist oxidation and corrosion.

19.3 In reference to 19.1 iron or carbon steel shall not be used for a current-carrying part unless provided with a corrosion-resistance coating or located within a motor.

20 Insulating Material

20.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other material with consideration given to its electrical and mechanical properties.

20.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage or warpage may reduce electrical spacings. Plastic materials may be used for the sole support of uninsulated live parts if found to have adequate mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric voltage-withstand, and other factors involved under conditions of intended service. All of these factors are considered with respect to thermal aging.

21 Switches And Controllers

21.1 Except as indicated in 21.2 and 21.3, a motor controller(s) shall be provided for all water coolers incorporating:

a) Two or more motors or

b) A motor(s) and other load(s) intended for connection to the same power supply.

21.2 The attachment plug and receptacle may serve as the controller on a cord connected water cooler if the marked ampere rating does not exceed the values shown in Table 21.1 for the voltage indicated.

Table 21.1
Ampere rating

Amperes	Voltage
7.2	115
4.0	208
3.6	230

21.3 A motor controller is not required for any supply circuit of a permanently connected water cooler which supplies:

a) Two or more motors or

b) A motor(s) and other load(s)

if, in either case, the marked maximum size of the supply circuit overcurrent protection device for that circuit does not exceed 20 amperes at 125 volts or less or 15 amperes at 600 volts or less, and if the rating of any motor in the circuit does not exceed 1 horsepower (746 W) and 6 full load amperes.

21.4 A cord-connected water cooler shall be provided with a motor controller which will shut off the complete water cooler or any motor load exceeding the values shown in 21.2.

21.5 A single-pole switching device including an automatic control having a marked “off” position, shall not be connected to the identified (grounded) conductor.

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21.6 A switch or other control device having a marked OFF position and is accessible without requiring the use of tools shall de-energize all loads in the water cooler when placed in the OFF position.

21.7 Switching devices shall be housed within an enclosure which will protect coils and contacts against mechanical damage, dirt, and moisture.

21.8 Except as specified in 21.9, a switch or other control device shall have current rating(s) based on the use applications specified in (a) – (d) and be acceptably rated for voltage, power factor, control device ambient temperature and other similar parameters as determined by the Temperature and Pressure Test, Section 62. Power factor requirements for each specific load type are specified in 74.5(a) – (d).

a) A manually operated control device having a marked off position and intended to control a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of:

1) The rated load current, maximum rated current or branch-circuit selection current of the motor-compressor, whichever is greater, and

2) The rated current of any other controlled loads.

b) A control device intended to control a motor load, such as a motor-compressor, shall have a current interrupting capacity equal to the larger of the locked-rotor current, maximum operating current or maximum rated current of the largest motor load plus the full load or maximum operating current of any other loads controlled by the switch.

c) A control device intended to control an inductive load, such as a transformer, shall have a current rating of not less than twice the total marked current ratings of the inductive loads that it controls.

d) Any switch or control device other than as specified in (a) – (c) shall have a current rating not less than the load it controls as determined by the Temperature and Pressure Test, Section 62.

21.9 A switch or other control device not complying with 21.8 shall comply with the Overload and Endurance Test for Operating Controls, Section 74.

21.10 A switch or other control device having a marked OFF position shall:

a) De-energize all loads when the switch is placed in the “OFF” position, if the switch is accessible without requiring the use of tools; and

b) Disconnect all ungrounded conductors of a supply circuit to a heater of a permanently connected water cooler. This requirement shall apply even if the switch with the marked “OFF” position controls another switching device which in-turn, provides power to the heater circuit.

21.11 Except as specified in 21.12, a temperature limiting (protective) control or replaceable thermal cutoff shall be provided to protect a water heater in a drinking water cooler against risk of fire or electrical shock. Compliance shall be determined by conducting the Burnout Test, Section 75, with the water heater operated dry and with any water heater temperature regulating (operating) controls electrically bypassed.

21.12 In reference to 21.11, a water heater not provided with or protected by a temperature limiting (protective) control or replaceable thermal cutoff shall comply with the Burnout Test in Section 75.1 with the water heater operated dry and with any water heater temperature regulating (operating) controls electrically bypassed.

21.13 A protective control, other than a motor or motor-compressor overload protective device (covered in Section 24), shall comply with one of the following:

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a) *Deleted.*

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6. The endurance cycle requirements in Table AA.1DV of UL 60730-2-6 for cut-outs shall be applied.

c) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9. The endurance cycle requirements in Table CC.2 of UL 60730-2-9 for cut-outs shall be applied.

d) *Deleted.*

e) Standard for Industrial Control Equipment, UL 508.

f) Standard for Switches for Appliances – Part 1 General Requirements, UL 61058-1; or

g) Paragraph 21.32 and the protective electronic circuits tests in Section 83.

21.14 In reference to 21.13 (e) – (g), the endurance cycle requirements in Table CC.2 of UL 60730-2-9 for cut-outs shall be applied to such controls.

21.15 A water heater protective temperature control not complying with the endurance requirements specified in 21.13 or 21.14 shall comply with the Water Heating Protective Controls Endurance Tests in 73.1.

21.16 In reference to 21.13(b), (c), (f) and (g), when determining the acceptability of a protective control, the control pollution degree shall be as specified in 48.3(a) – (d). In addition, if the protective control:

a) Has a protective electronic circuit, the factors in Table 24.2 shall be considered; and

b) Uses software as a required part of the protective electronic circuit, the software shall comply with 24.5.2(b) or (c).

21.17 A protective control other than of the type referenced in 24.2.1(a) – (b) shall :

a) Be an integral part of the water cooler;

b) Control the load(s) directly except as indicated in 21.18.

21.18 If a protective control indirectly controls the load through a switching device, the switching device shall comply with the endurance cycle requirements in 21.13 or 21.14. The switching device shall be an integral part of the water cooler.

21.19 A water heater temperature protective control shall comply with the calibration requirements specified by one of the following:

a) *Deleted.*

b) Table AADV.1 of UL 60730-2-9 with the storage water heater thermal cut-out requirements being applied; or

c) Water Heating Protective Controls Calibration Test in 73.2 such that the protective control:

1) Opens within ±5°F (±3°C) of the control set-point temperature as declared by the manufacturer; and

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2) Does not vary from the control initial (as-received) opening temperature by more than 10° F (6°C) or 5 percent, whichever is greater, following the Water Heating Protective Controls Endurance Tests in 73.1.

21.20 If the Water Heating Protective Controls Endurance Tests in 73.1 are conducted, the protective temperature control shall comply with the calibration requirement in 21.19(c)(2) following the endurance cycling of the control.

21.21 For a temperature protective control other than a water-heater temperature protective control, the cutout calibration temperature shall be ±10°F (±6°C) of its maximum marked set-point temperature.

21.22 The cutout calibration pressure of a pressure protective control (pressure-limiting device) shall not exceed 105 percent of its maximum marked setting.

21.23 Except as specified in 21.24, an operating control, including of the electronic type, shall comply with one of the following:

a) One of the Standards specified in 21.13 (b) – (f);

b) The requirements in this Standard as far as they reasonably apply; or

c) One of the following standards:

1) Standard for Solid-State Controls for Appliances, UL 244A;

2) Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1; or

3) Standard for Clock-Operated Switches, UL 917.

21.24 An operating control not complying with 21.23:

a) Shall be powered entirely by no more than one extra-low-voltage circuit; comply with the Limiting Impedance Test in UL 508; or comply with the low-power test requirement determined as specified in Clause 19.11.1 of UL 60335-1; and

b) If used to control a motor-compressor, shall comply with the endurance cycle requirements in UL 60730-2-9, Table CC.2 for air conditioning and refrigeration applications.

21.25 An operating control complying with 21.23 shall also comply with the following:

a) For electronic controls – Installation class 2 for electromagnetic compatibility (EMC) shall be in accordance with the voltage surge testing in 83.3.6 and comply with the results specified in 83.3.2;

b) Category II shall be the overvoltage category;

c) Insulating materials shall have a minimum comparative tracking index (CTI) of 100 (material group III);

d) The applicable Pollution Degree shall be as specified in 48.3 (a) – (d); and

e) The endurance cycle requirements specified by either of the following:

1) Table CC.2 of UL 60730-2-9 with the operating control (limiters) endurance cycle requirements being applied; or

2) The Overload and Endurance Test for Operating Controls, Section 74.

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21.26 If an operating control complying with 21.23 indirectly controls a load through a switching device, the switching device endurance cycle requirements shall be as specified in:

a) 21.24(b) if the switching device controls a motor-compressor; or

b) 21.25(e) if the switching device controls a load other than a motor-compressor.

21.26.1 If an operating control referenced by 21.24 indirectly controls a motor-compressor through a switching device, the switching device endurance cycle requirements shall comply with 21.24(b).

21.27 A general-use snap switch shall comply with the Standard for General-Use Snap Switches, UL 20.

21.28 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector.

21.29 Appendix B, Operating and Protective ("Safety Critical") Control Functions, shall be referenced to determine whether a control function is considered to result in a risk of fire, electrical shock or injury to persons.

21.30 If a control can be used to reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, but a redundant control (of similar or different design) operates to perform the identical function, the circuit shall be evaluated to determine which control will be relied upon as the protective control. The control determined to be the protective control shall comply with the protective control requirements in 21.13. The control determined to be the operating control is not required to comply with the protective control requirements but shall comply with the operating control requirements in 21.24 or with 21.23 and 21.25.

21.31 A thermistor shall comply with Annex J of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 or the Standard for Thermistor-Type Devices, UL 1434. The calibration shall be as specified in 21.19 if used as part of a water heater temperature protective control or in accordance with 21.21 if used with other controls. If a thermistor is used:

a) To reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, the minimum number of endurance cycles shall be 100,000.

b) In other sensing applications of the appliance, the minimum number of endurance cycles shall be 6,000.

21.32 A protective control as referenced in 21.13(g) or 24.5.1(c) and having a protective electronic circuit:

a) In which electronic disconnection of the circuit could fail, shall have at least two components whose combined operation provides the load disconnection;

b) Shall prevent a risk of fire, electric shock or injury to persons under the relevant fault conditions specified in Section 83.2;

c) In which an overcurrent protective device opens during application of any of the fault conditions specified in 83.2, shall utilize an overcurrent protective device complying with the requirements applicable to that component. The fault condition causing the overcurrent protective device to open shall be repeated and the overcurrent protective device shall again open the protective electronic circuit. If the overcurrent protective device complies with IEC 60127-1 Standard for Miniature Fuses: Part 1, Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links as well as an applicable Part 2, then the protective device shall additionally comply with the Fuse-Link Test in Section 83.5;

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d) In which a conductor of the printed wiring board becomes open-circuited during the fault conditions test in 83.2, then:

1) The printed wiring board shall comply with the Needle-Flame Test in Annex E of Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 or have a minimum flammability rating of V-0 when tested in accordance with the vertical flame test described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

2) Any loosened conductor shall not reduce spacings below the values specified in the relevant Sections 46 – 48; and

3) The specific test in which the printed wiring became open-circuited shall be repeated a second time. There shall be no risk of fire, electric shock or injury to persons and spacings shall not be reduced below the values specified in the relevant Sections 46 – 48.

e) Shall maintain its required functions when subjected to the EMC related stresses specified in the Electromagnetic Compatibility (EMC) Tests, Section 83.3; and

f) That relies upon a programmable component for one or more of its safety functions shall be subjected to the Programmable Component Reduced Supply Voltage Test, Section 83.4, unless restarting at any point in the operating cycle after interruption of operation due to a supply voltage dip will not result in a risk of fire, electric shock or injury to persons. The test shall be carried out after removal of all batteries and other components intended to maintain the programmable component supply voltage during supply source (mains) voltage dips, interruptions and variations.

22 Remotely Operated Water Coolers

22.1 Any water cooler function enabled in response to external communication or data signals shall be considered when determining normal and abnormal conditions of the appliance.

22.2 Except as specified in 22.3, a manual control shall be provided on a water cooler such that actuation of the control is required before the water cooler can be operated in any mode that permits remote operation, external communication or receiving/sending data signals.

22.3 In reference to 22.2, a water cooler not provided with a manual control for actuating remote operation, external communication or receiving/sending data signals shall be:

a) Capable of remote operation, external communication or receiving/sending data signals only within line-of-sight; or

b) Limited only to monitoring external communication or data signals.

22.4 A water cooler shall include a means to manually disconnect, disable or override any remote operation commands, external communication or data signals. If the water cooler attachment plug and receptacle serve as the manual means to disconnect data signals or remote operation commands, the water cooler shall comply with 21.2 and 6.7.

22.5 A control that operates in response to remote operation commands, external communication or data signals shall not introduce an operating condition or state that could lead to a risk of fire, electric shock or injury to persons. In addition, such a control shall not:

a) Render inoperative any protective control or protective control function within the water cooler;

b) Alter the order of control response such as by forcing a protective control to operate instead of another control that would normally be intended to respond;

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c) Reset any protective manual reset feature;

d) Supersede the response of any protective control; or

e) Alter the response to or expected performance of:

1) User actuation of controls, movement of doors, covers, grills, filters or the like; or

2) User interaction with any parts of the water cooler that could result in exposure of hazardous electrical parts, moving parts, hot parts or radiation.

22.6 Compliance with 22.5 shall be determined by one of the following:

a) Using methods appropriate for determining the performance and reliability of protective control functions in accordance with Section 21; or

b) Examining the water cooler circuit diagram(s) to determine that a control which operates in response to remote operation commands, external communication or data signals operates wholly independent of the water cooler protective controls and therefore is incapable of adversely affecting the operation of any protective controls.

23 Motors

23.1 Nonhermetic motors shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1. Hermetic motor-compressors shall comply with the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 and the Standard for Household and Similar Electrical Appliances – Safety – Part 2-34: Particular Requirements for Motor-Compressors, UL 60335-2-34.

23.2 Motors having openings in the enclosure or frame shall be arranged to prevent particles from falling out of the motor onto flammable material within or under the assembly. For built-in water coolers, also see 12.1.8 and 12.1.9.

23.3 In reference to 23.2 products with open-type motors shall comply with at least one of the following (a) – (c):

a) The cabinet is arranged such that any failure of the open-type motor shall not result in a risk of fire or emission of flame or molten metal;

b) The motor protective overload device provided with an open-type motor shall be such that no burning insulation or molten material falls to the surface that supports the water cooler when the motor is energized under each of the following fault conditions applicable to the motor type:

1) Open main winding,

2) Open starting winding,

3) Starting switch short-circuited,

4) Capacitor shorted, permanent split capacitor type.

c) The open-type motor shall be provided with a thermal motor protector (a protective device that is sensitive to temperature and current) that will prevent the temperature of the motor windings from becoming more than 257°F (125°C) under the maximum load under which the motor will run without causing the protector to cycle and from becoming more than 302°F (150°C) with the rotor of the motor locked.

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23.4 When a barrier is used for compliance with 23.3, the barrier shall be horizontal, shall be located as indicated in Figure 23.1, and shall 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 flammable material.

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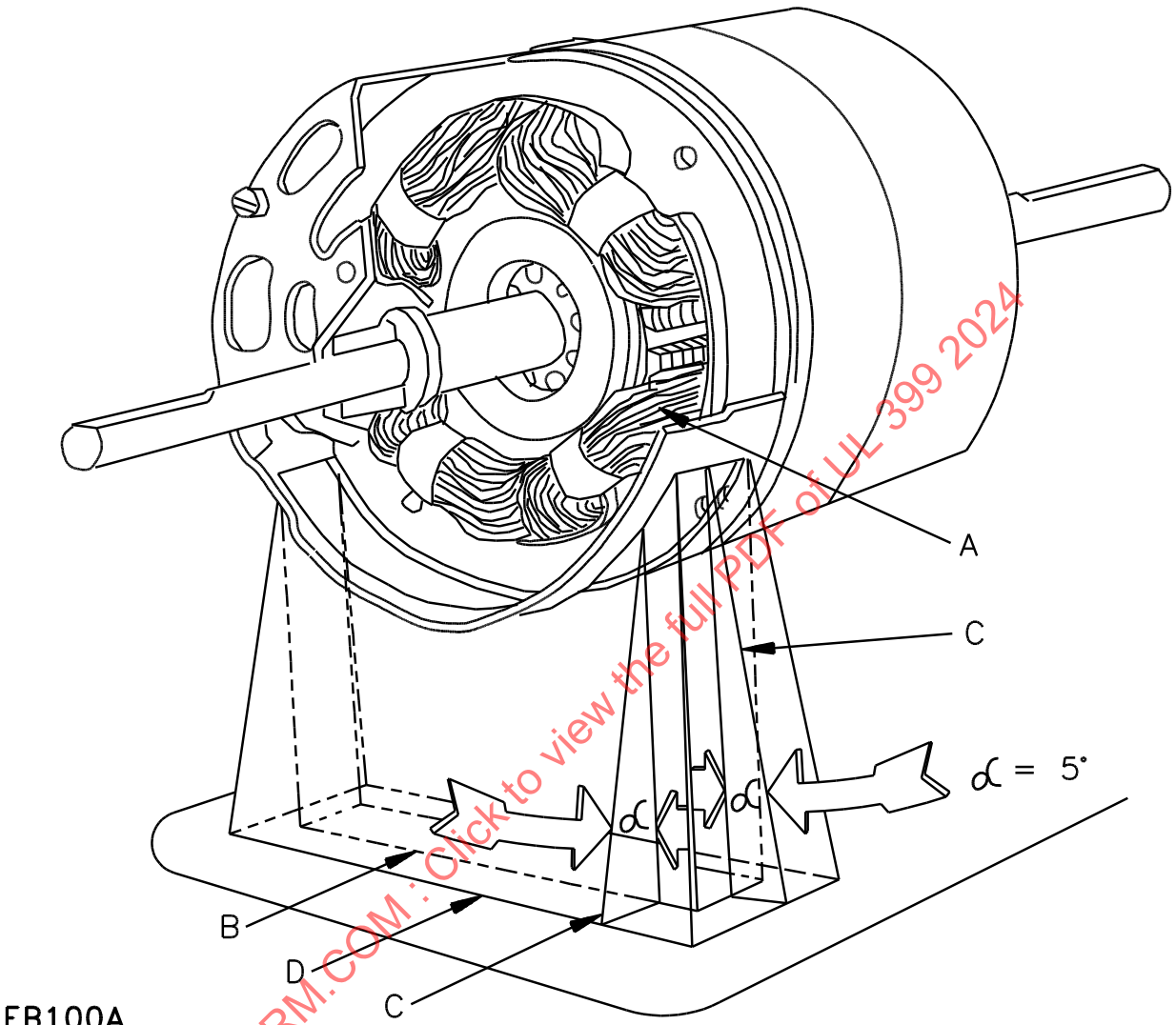
Figure 23.1

Location and extent of barrier



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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 shall be always tangent to the motor winding, five degrees from the vertical, and 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.

24 Motor Overload Protection

24.1 General

24.1.1 A fuse shall not be used as a protective device unless the motor is protected by the largest size fuse that can be inserted into the fuseholder.

24.1.2 Overcurrent protective devices and thermal protective devices for motors shall comply with applicable short-circuit requirements for the class of protective device and shall, in addition, comply with the requirements of the Limited Short-Circuit Test, Section 79.

24.2 Protection of single-phase nonhermetic motors

24.2.1 All single-phase motors other than a hermetic refrigerant motor compressor shall be protected by one 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 24.1;

b) A separate overload device which combines the functions of overload and overcurrent protection and is responsive to motor current rated or set at values not greater than the percentages of the motor nameplate full-load current rating as specified Table 24.1. Such a device shall be capable of fully protecting the circuit and motor both under overload and short circuit conditions; or

c) In accordance with the Standard for Tests for Impedance Protected Motors, UL 1004-2 for impedance protected motors; or

d) In accordance with the Standard for Thermally Protected Motors, UL 1004-3 for thermally protected motors; or

e) In accordance with 24.5 or the Standard for Electronically Protected Motors, UL 1004-7 for electronically protected motors.

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Table 24.1
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	125	140
Any other motor	115	130

24.2.2 In reference to 24.2.1(a) and (b), if the percentage protection specified in Column A of Table 24.1 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 overload device of the next higher size shall provide protection no higher than that indicated in Column B of Table 24.1.

24.3 Protection of single-phase hermetic refrigerant motor-compressors

24.3.1 Single-phase hermetic refrigerant motor-compressors shall be protected by one of the following:

a) A separate overload relay that is responsive to motor compressor current and will trip at not more than 140 percent of the rated load current of the motor compressor;

b) A thermal protector integral with the motor compressor or a protective system that complies with the applicable requirements in the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 and the Standard for Household and Similar Electrical Appliances – Safety – Part 2-34: Particular Requirements for Motor-Compressors, UL 60335-2-34; or

c) An overcurrent device, such as a fuse or circuit breaker, responsive to motor current, and rated at no more than 125 percent of the motor-compressor rated-load current of the motor-compressor.

24.3.2 In reference to 24.3.1(b):

a) A protector or protective system, provided by other than an adjustable speed drive or system, for a water cooler exceeding the ratings specified in 99.14(c) shall not permit a continuous current in excess of 156 percent of the motor-compressor rated load current or branch-circuit selection current (if the latter is marked); and

b) If a protective system is used, all components shall be provided as part of the water cooler.

24.3.3 In reference to 24.3.1(c), the water cooler shall be capable of starting and operating as intended with the overcurrent device provided.

24.3.4 The values of rated-load current and branch-circuit-selection current specified in 24.3.2 shall be the values marked on the water cooler nameplate. For a cord-connected water cooler or a permanently connected water cooler marked with a single-ampere rating, the rated load current as specified in 24.3.2 shall be the current drawn by the motor-compressor during the Temperature and Pressure Test, Section 62.

24.4 Protection of three-phase motors

24.4.1 Three-phase motors shall be protected by:

a) Three properly rated overcurrent units, each complying with 24.2 or 24.3; or

b) other protective methods if the methods provide protection under primary single-phase failure conditions when supplied from wye-delta or delta-wye connected transformers. Water coolers with such protective methods shall be marked as described in 99.18.

24.5 Protective electronic circuits

24.5.1 A protective electronic circuit providing motor protection in accordance with 24.2, 24.3 or 24.4 shall comply with one of the following:

a) *Deleted.*

a) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 as well as the specific applicable Part 2;

c) Paragraph 21.32 and the protective electronic circuits tests in Section 83; or

b) Not create any risk of fire, electric shock or injury to persons under abnormal conditions with the protective electronic circuit rendered ineffective (open or short-circuited), e.g. use of a redundant circuit or control.

24.5.2 In reference to 24.5.1, software in a protective electronic circuit required as part of a motor protective device or system shall comply with one of the following:

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a) *Deleted.*

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 as well as the specific applicable Part 2 and be software Class B;

c) Annex R of the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 and be software Class B; or

d) Not create any risk of fire, electric shock or injury to persons under abnormal conditions with the software rendered ineffective, e.g. use of independent redundant protective devices.

24.5.3 With reference to 24.5.1 and 24.5.2, the factors outlined in Table 24.2 shall be considered when evaluating a protective electronic circuit.

Table 24.2
Factors for judging protective electronic circuits

1	Conducting failure-mode and effect analysis (FMEA) for the protective circuits and functions.
2	Electrical supervision of critical components resulting in the control becoming permanently inoperative and disconnecting power.
3	Temperature ranges as follows: **Indoor Equipment** 32.0 ±3.6°F (0.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C) **Outdoor Equipment** minus 31.0 ±3.6°F (minus 35.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C)
4	Cycling test duration: 14 days
5	Endurance test duration: 100,000 cycles
6	Radio-frequency electromagnetic field immunity: **A.** To conducted disturbances – test level 3 **B.** To radiated electromagnetic fields – Evaluate in accordance with 83.3.4 and 83.3.2.
7	Humidity exposure: **Indoor Equipment** 70 – 80°F (21.1 – 26.7°C) and minimum 50 percent relative humidity **Outdoor Equipment** Same as indoor equipment except minimum 98 percent relative humidity
8	Electrical fast transient/burst immunity: **Outdoor Equipment** Test level 4 **All Other Equipment** Test level 3
9	Surge immunity: **Outdoor Equipment** Installation Class 4 **All Other Equipment** Installation Class 3
10	Electrostatic Discharge with a Severity Level of 3 having contact discharge at 6 kV to accessible metal parts and Air discharge at 8 kV to accessible parts of insulating material.
11	Voltage Dips and Interruptions: Evaluate in accordance with 83.3.8 and 83.3.2.
12	Harmonics and Interharmonics: Evaluate in accordance with 83.3.9 and 83.3.2.
13	Calibration (deviation and drift): Evaluate in accordance with 21.21 for a temperature protective control or 21.22 for a pressure protective control.

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25 Electric Water Heaters

25.1 Heater elements

25.1.1 Electric resistance heating elements shall comply with 25.1.2 – 25.1.8 or with the construction requirements of one of the following:

a) Standard for Electric Heating Appliances, UL 499; or

b) Standard for Sheathed Heating Elements, UL 1030.

25.1.2 A heater in a hot- and cold-type water cooler shall be an encased assembly constructed of materials which will not be damaged by the temperature to which they will be subjected in the water cooler.

25.1.3 Metal tubing forming a heater element enclosure shall be constructed of corrosion resistant material or shall be plated, dipped, or coated to resist external corrosion and shall be acceptable for the temperatures to which it is subjected. See 25.1.4.

25.1.4 Uncoated copper tubing may be employed for temperatures of 392°F (200°C) and lower; metallic coated copper tubing is acceptable for temperatures below the melting temperature of the coating. Uncoated or oxide-coated steel tubing is not considered acceptable as a heater sheath. Plated steel tubing may be employed if the coating is determined to be corrosion resistant and will withstand the temperatures to which it may be subjected. Aluminum tubing may be employed if the alloy withstands a burnout test without melting or other failure. Stainless steel tubing of the austenitic grades such as ASTM Type 304 is generally acceptable for heater sheaths.

25.1.5 Insulating materials, such as washers and bushings, which are integral parts of a heating element shall be of a moisture resistant material which will not be damaged by the temperatures to which they will be subjected in the water cooler.

25.1.6 Insulating material employed in a heating element shall be acceptable as the sole support of live parts. Materials such as magnesium oxide may be used in conjunction with other insulating materials if located and protected so that mechanical damage is prevented and if not subjected to the absorption of moisture. When it is necessary to investigate a material, consideration is to be given to such factors as mechanical strength, dielectric voltage withstand, insulation resistance, see 78.1.1 – 78.1.5, heat resistant qualities, and the degree to which it is enclosed or protected. All of these factors are considered with respect to thermal aging.

25.1.7 To comply with the requirements of 25.1.2, a heater case or a terminal seal of rubber, neoprene, or thermoplastic materials shall have acceptable aging properties for temperatures measured during heating tests. See Accelerated Aging Test – Electric Heaters, Section 84.

25.1.8 An electric heater assembly shall be sealed to prevent entrance of moisture. See Insulation Resistance Test, Section 78. Molded seal caps, vulcanized to the heater leads and heater sheath, shall have a wall thickness equivalent to that required for the heater leads.

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25.2 Water heater thermal cutoffs

25.2.1 Thermal cutoffs shall comply with the requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

25.2.2 A thermal cutoff shall be secured in place and located so that:

a) It will be accessible for replacement without damaging other connections; and

b) Replacement of the thermal cutoff will not result in displacement or disturbance of internal wiring other than leads to the cutoff itself or to a heating element assembly on which the cutoff is mounted.

26 Valves and Solenoids

26.1 An electrically operated valve or solenoid shall comply with the Standard for Electrically Operated Valves, UL 429 or comply with 26.3 – 26.4.

26.2 If a valve must be cleaned periodically, the arrangement shall permit this operation to be performed without damage to the electrical parts of the valve or wiring.

26.3 Coil windings of electrically operated valves or solenoids shall be impregnated, dipped, varnished, or otherwise treated to resist absorption of moisture.

26.4 Except as indicated in 26.1, an electrically operated valve or solenoid shall comply with the requirements of the Burnout Test, Section 75.

27 Capacitors

27.1 A motor start or run capacitor shall comply with the Standard for Capacitors, UL 810 or shall:

a) Be housed within a cabinet, enclosure or other similar container which will protect the plates against mechanical damage and which will prevent the emission of flame or molten material resulting from failure of the capacitor.

b) Have a capacitor container that is protected against corrosion as specified in 12.3.1 if a ferrous metal capacitor container is exposed to the effects of weathering, and be:

1) Made of coated or uncoated sheet steel having a thickness of not less than 0.020 inch (0.51 mm); or,

2) Mounted within the water cooler cabinet or enclosure if the sheet steel is thinner than 0.020 inch (0.51 mm) or if materials other than metal are used as the capacitor container.

c) Be protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard, including faulted overcurrent conditions as specified in the Limited Short-Circuit Test, Section 79. The conditions for the Limited Short-Circuit Test shall be:

1) Based on the circuit on which the capacitor is used; or,

2) If the available fault current is limited by other components in the circuit, such as a motor start winding, the capacitor may be tested using a fault current less than the test current specified in Table 79.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

27.2 *Deleted*

27.3 *Deleted*

27.4 If the container of an electrolytic capacitor is metal, the container shall be considered to be a live part and shall be provided with moisture-resistant electrical insulation to isolate it from dead metal parts and to prevent contact during servicing operations. The insulating material shall be not less than 1/32 inch (0.8 mm) thick except as indicated in 46.9.

27.5 *Deleted*

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27.6 Across-the-Line Capacitors, Antenna-Coupling Components, Line-Bypass Components and Fixed Capacitors for Use in Electronic Equipment shall comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

27.7 In reference to 27.6, a capacitor complying with UL 60384-14 shall have specifications as follows:

a) Operating voltage – Not less than 110 percent of the water cooler rated voltage;

b) For capacitors connected across the line (phase-to-phase) – Subclass X1 (≤ 4.0 kV) or X2 (≤ 2.5 kV) for impulse voltage (based on minimum Overvoltage Category of II);

c) For capacitors connected from line to ground – Subclass Y1 or Y2 for any water coolers having a rated voltage not exceeding 500 volts; or as an alternate, subclass Y4 if a water cooler has a rated voltage not exceeding 150 volts;

d) Upper category temperature – Based on the maximum capacitor surface temperature measured during the Temperature and Pressure Test in Section 62, but not less than 185°F (85°C);

e) Lower category temperature – Based on the minimum surface temperature for which the capacitor has been designed to operate when installed within a water cooler as intended, but not greater than 14ºF (minus 10ºC);

f) Duration of the damp-heat steady-state test – Not less than 21 days; and

g) Passive flammability category B or C. As an alternate, a polymeric capacitor case shall have a V-0 flame rating as described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

27.8 In reference to 27.6, a capacitor shall consist of a single Class Y1 capacitor or two Class Y2 capacitors connected in series if it is connected between:

a) Two line conductors in a primary circuit;

b) One line conductor and the neutral conductor;

c) Primary and accessible secondary circuits; or,

d) The primary circuit and protective earth (equipment grounding conductor connection).

28 Transformers

28.1 A transformer other than one as described in 28.4 shall have a secondary rating not less than the connected load, except the load may be greater than the marked rating if the transformer does not exceed the maximum allowable temperature during the Temperature and Pressure Test, Section 62.

28.2 A transformer (including an autotransformer), other than one as described in 28.4, is considered to be a high-voltage transformer and shall:

a) Comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2; and

b) Not result in a risk of fire if a transformer supplied motor load locks or fails to start.

28.3 A transformer designed to furnish power to an extra-low-voltage circuit shall be of the two-coil insulated type.

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28.4 A transformer that directly supplies a National Electrical Code, NFPA 70, Class 2 circuit shall, in accordance with the Standard for Low Voltage Transformers – Part 1: General Requirements – UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers – UL 5085-3, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer).

29 Batteries and Battery Chargers

29.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion multiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

29.2 Rechargeable nickel cadmium (Ni-Cad) and nickel metal-hydride (Ni-MH) battery cells and packs shall comply with the requirements in this Standard and with the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

29.3 A battery charger that is other than Class 2 shall comply with 39.1. A Class 2 battery charger shall comply with 39.1.

30 Circuit Breakers, Fusing Resistors and Supplementary Protectors

30.1 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489. In addition, circuit breakers used in telecommunications circuitry shall comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A.

30.2 Circuit breakers used to protect circuits having more than one ungrounded conductor and no grounded neutral shall be of the multipole common trip type arranged to open all ungrounded conductors. The use of external handle ties does not in itself constitute a common trip mechanism.

30.3 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

30.4 Supplementary Protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

30.5 A fusing resistor or supplementary protector shall not be used in place of a circuit breaker or protective control.

31 Connectors

31.1 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

32 Electrical Cable, Conduit and Tubing

32.1 Aluminum or steel armored cable shall comply with the Standard for Armored Cable, UL 4. Nonmetallic sheathed cables shall comply with the Standard for Nonmetallic Sheathed Cables, UL 719.

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32.2 Flexible metal conduit shall comply with the Standard for Flexible Metal Conduit, UL 1. Rigid steel conduit shall comply with the Standard for Electrical Rigid Metal Conduit – Steel, UL 6.

32.3 Electrical steel tubing shall comply with the Standard for Electrical Metallic Tubing – Steel, UL 797.

33 Electrical Insulation Systems

33.1 Film-coated wire or materials used in an insulation system that operates at or above Class 105 (Class A) shall comply with the Standard for Systems of Insulating Materials – General, UL 1446. The requirements for film-coated wire or materials used in insulation systems that operate below Class 105 (Class A) are unspecified.

33.2 Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510.

33.3 Insulating sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441.

33.4 Insulating tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

34 Electromagnetic Interference Filters

34.1 Electromagnetic interference filters shall comply with the:

a) Standard for Electromagnetic Interference Filters, UL 1283; or

b) Standard for Passive Filter Units for Electromagnetic Interference Suppression – Part 3: Passive Filter Units for Which Safety Tests are Appropriate, UL 60939-3.

35 Fuses and Fuseholders

35.1 Unless otherwise specified, fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, in conjunction with any of the associated standards tabulated below, as applicable for the class of fuse:

a) The Standard for Low-Voltage Fuses – Part 4: Class CC Fuses, UL 248-4,

b) The Standard for Low-Voltage Fuses – Part 5: Class G Fuses, UL 248-5,

c) The Standard for Low-Voltage Fuses – Part 8: Class J Fuses, UL 248-8,

d) The Standard for Low-Voltage Fuses – Part 9: Class K Fuses, UL 248-9,

e) The Standard for Low-Voltage Fuses – Part 10: Class L Fuses, UL 248-10,

f) The Standard for Low-Voltage Fuses – Part 11: Plug Fuses, UL 248-11,

g) The Standard for Low-Voltage Fuses – Part 12: Class R Fuses, UL 248-12,

h) The Standard for Low-Voltage Fuses – Part 15: Class T Fuses, UL 248-15.

35.2 If a supplementary fuse is permitted in accordance with the requirements in this standard, such a fuse shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, in conjunction with the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14.

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35.3 Fuseholders shall either comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, in conjunction with any of the associated standards tabulated below, as applicable for the class of fuseholder:

a) The Standard for Fuseholders – Part 4: Class CC, UL 4248-4,

b) The Standard for Fuseholders – Part 5: Class G, UL 4248-5,

c) The Standard for Fuseholders – Part 8: Class J, UL 4248-8,

d) The Standard for Fuseholders – Part 9: Class K, UL 4248-9,

e) The Standard for Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse, UL 4248-11,

f) The Standard for Fuseholders – Part 12: Class R, UL 4248-12,

g) The Standard for Fuseholders – Part 15: Class T, UL 4248-15.

35.4 A fuseholder shall be installed, or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. A barrier of vulcanized fiber or similar material employed as a guard for high-voltage live parts shall be not less than 1/32 inch (0.8 mm) in thickness. A separation less than 4 inches (102 mm) is considered to be adjacent.

35.5 A plug fuseholder intended to be connected to a 125 or a 125/250 volt, 3-wire circuit shall be wired in the unidentified (ungrounded) conductor with the screw shell connected toward the load.

35.6 A plug fuseholder of the Edison-base type shall be provided with an adapter designed for Type S fuses.

36 Lighting Systems

36.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

36.2 Lighting ballasts shall comply with one of the following:

a) Standard for Fluorescent-Lamp Ballasts, UL 935; or

b) Standard for High-Intensity-Discharge Lamp Ballasts, UL 1029.

36.3 Light Emitting Diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use in Lighting Products, UL 8750.

37 Optical Isolators and Semiconductor Devices

37.1 An optical isolator shall comply with the Standard for Optical Isolators, UL 1577 if it is relied upon to provide isolation between:

a) Primary and secondary circuits;

b) Extra-low-voltage safety circuits; or

c) Other high-voltage circuits.

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37.1.1 In addition to complying with 37.1, an optical isolator relied upon to provide feedback between primary and secondary circuits of a switch mode power supply unit shall have a minimum isolation voltage of 1500V.

37.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. If the switching semiconductor is used as part of a switch mode power supply unit, it shall have a minimum isolation voltage of 1500V.

38 Outlet Boxes

38.1 Outlet boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A or the Standard for Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers, UL 514C. Fittings shall comply with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B. Cover plates shall comply with the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

39 Power Supplies

39.1 A power supply shall comply with one of the following:

a) For a Class 2 Power Supply:

1) Standard for Class 2 Power Units, UL 1310;

2) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 with an output marked “Class 2” or that complies with the limited power source (LPS) requirements and is marked “LPS”; or

3) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: General Requirements, UL 62368-1 and with the limited power source requirements and is marked “LPS”.

b) For a power supply that is other than Class 2:

1) Standard for Power Units Other Than Class 2, UL 1012;

2) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1; or

3) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: General Requirements, UL 62368-1.

c) For a switch mode power supply unit not complying with (a) or (b), the relevant requirements in this Standard, including the Switch Mode Power Supply Units – Overload Test, Section 79A, shall be applied.

39.2 *Deleted*

40 Receptacles

40.1 Receptacles shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

40.2 Unless intended to be connected to a power supply separate from that supplying other loads, a receptacle shall be rated at 15 or 20 amp, 125 or 250 V.

40.3 Receptacles shall be of the grounding type.

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40.4 A 125 volt, single-phase, 15 or 20 ampere receptacle shall have ground-fault circuit-interrupter (GFCI) protection. The GFCI shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

40.5 Receptacles shall be mounted with the receptacle face not less than 60 degrees from the horizontal and located so that liquid due to overflow, splashing, leakage, and cleaning will not enter.

40.6 Overcurrent protection shall be provided as part of the water cooler for each receptacle. The overcurrent protection shall be provided by a circuit breaker(s) or fuse(s) acceptable for branch circuit use.

41 Terminal Blocks

41.1 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

41.2 In reference to 41.1, if a fabricated part performs the function of a terminal block, the part shall comply with 13.2 (Terminals), 19 (Current-Carrying Parts), 20 (Insulating Material), and the spacings requirements as applicable to the type of circuit as specified below:

a) High-Voltage Circuit Spacings (Section 46); or

b) Extra-low voltage circuit spacings (Section 47).

41.3 If a fabricated terminal block complies with the alternate spacings requirements in Section 48, but not with the spacings requirements in Section 46, the terminal block shall not be used for field wiring.

42 Wireways, Auxiliary Gutters and Associated Fittings

42.1 Wireways, Auxiliary Gutters and Associated Fittings shall comply with the Standard for Wireways, Auxiliary Gutters and Associated Fittings, UL 870.

43 Ultraviolet (UV) Radiation Systems

43.1 Ultraviolet radiation lamp assemblies shall comply with Section 36. Nonmetallic parts of UV lamp assemblies shall comply with Section 58.

43.2 Emissions of UV radiation from a water cooler with ultraviolet radiation lamps shall not exceed the 8 hour level of effective irradiance of 0.1 μW/cm^2 when measured at a distance of 0 inches (0 mm) away from the water cooler. This includes any UV emissions that may be measured from the water inlet or outlet connections.

43.3 The test specified in 87 shall be conducted to determine compliance with 43.2.

44 Across-The-Line Capacitors, Antenna-Coupling Components, Line-Bypass Components and Fixed Capacitors for Use in Electronic Equipment

44.1 *Deleted*

44.2 *Deleted*

45 Information Technology Equipment

45.1 Information technology equipment such as a printer, visual display unit, router, communication connectors/data ports or computer shall comply with the:

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a) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1; or,

b) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: General Requirements, UL 62368-1.

SPACINGS

46 High-Voltage Circuits

46.1 The following electrical spacing requirements apply to high-voltage circuits, as defined in 5.10(a).

46.2 Unless specifically noted otherwise, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall be not less than the values indicated in Table 46.1.

Table 46.1
Electrical spacings in refrigerated and/or air-handling compartments

Ratings volt-amperes	Volts	Minimum spacing					
		Through air,		Over surface[a],		To outer enclosure or cabinet[c],	
		inch	(mm)	inch	(mm)	inch	(mm)
2000 or less	300 or less	1/8[b]	(3.2)	1/4	(6.4)	1/4	(6.4)
2000 or less	301 – 600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)
More than 2000	150 or less	1/8[b]	(3.2)	1/4	(6.4)	1/2	(12.7)
	151 – 300	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
	301 – 600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)

[a] At points other than field-wiring terminals, the spacings for heater elements only may be as indicated below provided the elements are not subject to moisture, such as may result from condensation on cooled surfaces:

1/16 inch (1.6 mm) through air and over surface for heaters rated 0 – 300 volts.

1/4 inch (6.4 mm) through air and over surface for heaters rated 301 – 600 volts.

[b] The spacings between wiring terminals of opposite polarity or between a wiring terminal and ground shall be not less than 1/4 inch (6.4 mm), except that if short-circuiting or grounding of such terminals will not result from projecting strands of wire, spacing need not be greater than that given in the above table. Wiring terminals are those connected in the field and not factory wired.

[c] Includes fittings for conduit or metal-clad cable.

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46.3 The Through-air and Over-surface spacings given in Table 46.1 and Table 46.2 at an individual component part are to be based on the total volt-ampere consumption of the load or loads which the component controls. For example, the spacings at a component which controls only the compressor motor are based on the volt-amperes of the compressor motor. The spacings at a component which controls loads in addition to the compressor motor are based on the sum of the volt-amperes of the loads so controlled, except that spacings at a component which independently controls separate loads are based on the volt-amperes of the larger load. The volt-ampere values for the loads referred to above are to be determined by the marked rating of the loads, except that for loads which are not required to have a marked rating, the measured input is to be used in determining the volt-ampere values.

Table 46.2
Spacings in non-refrigerated and/or non-air handling compartments

Ratings,		Minimum spacing					
		Through air,		Over surface,		To enclosure[b],	
volt-amperes	volts	inches	(mm)	inches	(mm)	inches	(mm)
0 – 2000	0 – 125	1/16	(1.6)	1/16	(1.6)	1/4	(6.4)
	126 – 250	3/32	(2.4)	3/32	(2.4)	1/4	(6.4)

NOTE – See 46.6.

[a] Includes fittings for conduit or metal-clad cable.

46.4 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity in accordance with the requirements indicated above and shall be based on the highest voltage involved.

46.5 With reference to 46.2 and 46.3, the "To outer enclosure or cabinet" spacings given in Table 46.1 are not to be applied to an individual enclosure of a component part within the outer enclosure or cabinet.

46.6 The spacings indicated in Table 46.2 are applicable only to electrical components mounted in totally enclosed nonrefrigerated and/or nonair handling compartments which are free of moisture, including that caused by condensation. At wiring terminals and for circuits over 250 volts or over 2000 volt-amperes, spacings in Table 46.1 apply.

46.7 If higher than rated potential is developed in a motor circuit through the use of capacitors and if the developed steady-state potential as determined during the Temperature and Pressure Test, Section 62:

a) Exceeds 500 volts, the developed potential shall be used as the basis for determining the spacings for the affected parts.

b) Does not exceed 500 volts, the rated voltage of the system shall be used as the basis for determining the spacings for the affected parts.

46.8 The electrical clearance resulting from the assembly of a component into the complete machines, including clearance to dead metal, metal enclosures or metal cabinets, shall be as indicated herein.

46.9 An insulating liner or barrier of fiber or similar material employed where spacings would otherwise be less than the required values shall be located or of such material that it will not be adversely affected by arcing and be:

a) Not less than 1/32 inch (0.8 mm) thick;

b) Not less than 1/64 inch (0.4 mm) thick if used in conjunction with an air spacing of not less than 50 percent of the required air spacing; or,

c) Another thickness if the insulating, mechanical and flammability properties of the material are equivalent to those specified in (a) and (b).

46.10 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part or enclosure shall be not less than 1/2 inch (12.7 mm) if the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

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47 Extra Low-Voltage Circuits

47.1 The following electrical spacing requirements apply to extra low-voltage circuits, as defined in 5.10(b).

47.2 A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not an extra low-voltage circuit.

47.3 The spacings for low-voltage electrical components installed in a circuit which includes a pressure-limiting device, motor overload protective device, or other protective device, where a short or grounded circuit may result in unsafe operation of the equipment, shall comply with the following:

a) The spacing between an uninsulated live part and the wall of a metal enclosure including fittings for the connection of conduit or metal-clad cable shall be not less than 1/8 inch (3.2 mm).

b) The spacing between wiring terminals regardless of polarity and between the wiring terminal and a dead metal part, including the metal enclosure or metal cabinet and fittings for the connection of conduit, which may be grounded when the device is installed, shall be not less than 1/4 inch (6.4 mm).

c) The spacing between uninsulated live parts regardless of polarity and between an uninsulated live part and a dead metal part, other than the metal enclosure , or metal cabinet which may be grounded when the device is installed, shall be not less than 1/32 inch (0.8 mm) provided that the construction of the parts is such that spacings will be maintained.

47.4 The spacings in extra low-voltage circuits which do not contain devices such as indicated in 47.3 are not specified.

48 Alternate Spacings – Clearances and Creepage Distances

48.1 Except as indicated in 48.2, the spacings requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, are applicable as an alternative to the specified spacings requirements in the following:

a) High-Voltage Circuits – Section 46; and

b) Extra-Low-Voltage Circuits – Section 47

48.2 The spacings requirements in UL 840 shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure.

48.3 The items outlined in (a) – (f) shall be considered when evaluating a water cooler to the requirements in UL 840.

a) Hermetically sealed or encapsulated enclosures are identified as pollution degree 1.

b) Coated printed wiring boards are identified as pollution degree 1 if they comply with one of the following:

1) Printed wiring board coating performance test of UL 840; or

2) Conformal coating requirements as outlined in the Standard for Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E.

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c) Indoor use water coolers are identified as pollution degree 2.

d) Outdoor use water coolers are identified as pollution degree 3.

e) Category II is the overvoltage category.

f) Printed wiring boards are considered as having a minimum comparative tracking index (CTI) of 100 unless further investigated for a higher CTI index.

48.4 Clearance B (Controlled Overvoltage) clearances as specified in UL 840 shall be achieved by providing an overvoltage device or system as an integral part of the drinking water cooler.

REFRIGERATION SYSTEM

49 Refrigerant

49.1 A drinking water cooler shall not employ a refrigerant with a toxicity safety group classification exceeding Class A as described by the Standard for Designation and Safety Classification of Refrigerants, ASHRAE 34.

49.2 The refrigerant employed in the system shall:

a) Have flammability characteristics that have been evaluated in accordance with the Standard for Refrigerants, UL 2182; or

b) Be subjected to a compositional analysis to confirm a composition consistent with a refrigerant specified in the Standard for Designation and Safety Classification of Refrigerants, ASHRAE 34.

49.3 In reference to 49.2(b), the chemical composition of the refrigerant, including the nominal composition (types and percentages) of a blended refrigerant, shall be determined by analytical testing in accordance with 90 using:

a) Infrared spectroscopy for single component refrigerants; or

b) Gas chromatography for blended refrigerants.

50 Pump-Down Capacity

50.1 This section of a water cooler designed to receive the refrigerant charge during a pump-down shall have the capacity to receive the charge without the liquid occupying more than 90 percent of the volume of the section when the temperature of the refrigerant is 90°F (32.2°C).

51 Refrigerant Tubing and Fittings

51.1 Copper or steel tubing used to connect refrigerant-containing components shall have a wall thickness not less than indicated in Table 51.1.

Exception No. 1: Copper or steel capillary tubing which is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 inch (0.51 mm).

Exception No. 2: Special alloys used for refrigerant – containing component tubing shall be evaluated for their:

a) Resistance to mechanical abuse,

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b) Strength against internal pressure,

c) Resistance to corrosion,

d) Protection against refrigerant contamination, and

e) Conformity with requirements of safety codes, such as the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15, as compared to tubing of the minimum wall thicknesses indicated in Table 51.1.

Table 51.1
Minimum wall thickness for copper and steel tubing

Outside diameter,		Copper				Steel	
		Protected[a]		Unprotected			
inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)
5/16	(7.9)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)
3/8	(9.5)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)
1/2	(12.7)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)
5/8	(15.9)	0.0315	(0.800)	0.0315	(0.800)	0.032	(0.81)
3/4	(19.1)	0.0315	(0.800)	0.0385	(0.978)	0.032	(0.81)
7/8	(22.2)	0.0410	(1.041)	0.0410	(1.041)	0.046	(1.17)
1	(25.4)	0.0460	(1.168)	0.0460	(1.168)	–	–

NOTE – Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.

[a] Within the product.

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51.2 Tubing shall be constructed of corrosion resistant material, such as copper, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion. Aluminum may be used where the material is not subject to galvanic corrosion.

51.3 Tubing forming part of components, such as evaporators or condensers, shall be protected by the design and evaluated in accordance with the requirements of the Strength Tests – Pressure Containing Components, Section 81.

51.4 Tubing connections shall be made by means of flare-type fittings with steel or forged brass nuts, by soldering or brazing, or by equivalent means. Flare-type fittings shall conform to the Refrigeration Tube Fittings-General Specifications, SAE J513.

52 Refrigerant-Containing Parts

52.1 Except as indicated in 52.2, parts of a water cooler subjected to refrigerant pressure shall withstand, without failure, the pressures indicated in the Strength Tests – Pressure Containing Components, Sections 81.1 – 81.4.

52.2 High side parts that do not comply with Sections 81.1, 81.2 and 81.4 shall comply with the Fatigue Test in the Standard for Refrigerant-Containing Components and Accessories, Nonelectrical, UL 207.

52.3 In reference to 52.2, if a high-side refrigerant containing part is subjected to the Fatigue Test, then the maximum abnormal or design pressure values required for this test shall be based on the maximum

refrigerant pressures obtained on the refrigerant-containing part during the testing of the water cooler in accordance with this standard.

52.4 If the high-side design pressure marked on the equipment as described in 97.2(e) equals or exceeds the critical pressure of the refrigerant, and if the Fatigue Test is conducted in accordance with 52.2, then the upper pressure for the high-side parts during the:

a) First cycle shall be the higher of either the equipment maximum abnormal or marked design pressure; and

b) Remaining cycles shall be not less than 95 percent of the higher of either the equipment maximum abnormal or marked design pressure.

52.5 In reference to 52.4, the lower pressure for all cycles shall not be greater than the saturated vapor pressure of the refrigerant at 40°F (4.4°C). For R744, this value is 553 psig (3.8 MPa).

52.6 The parts of a water cooler subjected to refrigerant pressure shall be constructed of corrosion resistant material, such as copper or stainless steel, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion.

52.7 Pressure vessels, as referred to in this standard, are any refrigerant-containing parts other than compressors, controls, evaporators, each separate section of which does not exceed 1/2 cubic foot (0.01 m^3) of refrigerant-containing volume, evaporator and condenser coils, headers, pipe, and pipe fittings.

52.8 Pressure vessels over 6 inches (152 mm) inside diameter shall be constructed, tested, and stamped in accordance with Section VIII of the Boiler and Pressure Vessel Code, ASME, for a working pressure in compliance with the Performance section of this standard.

52.9 Pressure vessels bearing the ASME Code "U" symbol complying with 52.8 are considered acceptable without tests.

52.10 Pressure vessels bearing the ASME Code "UM" symbol are to be tested to determine compliance with the requirements of the Strength Tests – Pressure Containing Components, Section 81. The manufacturer is to submit evidence of compliance of these vessels with Section VIII of the Boiler and Pressure Vessel Code, ASME.

53 Pressure-Limiting Device

53.1 A pressure-limiting device designed to automatically stop the operation of the compressor shall:

a) Be installed on all water coolers with a system containing more than 22 pounds-mass (10 kg) of refrigerant; and

b) Comply with 21.13, 21.14 and 21.22.

c) *Deleted*

53.2 The adjustable cutout pressure setting of a pressure-limiting device shall not exceed one-third of the ultimate strength of high-side refrigerant-containing parts provided this setting does not exceed 90 percent of the setting of the pressure-relief device.

53.3 There shall be no stop valves between the pressure-limiting device and the compressor.

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54 Pressure Relief

54.1 General

54.1.1 A water cooler shall be constructed so that pressure due to fire, or other abnormal conditions, will be safely relieved. Pressure-relief devices, fusible plugs, soldered joints, or special terminals may be employed for this purpose. See 54.2.1.

54.1.2 A pressure-relief device is a pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

54.1.3 Fusible plugs and rupture members shall comply with the Standard for Refrigerant-Containing Components and Accessories, Nonelectrical, UL 207.

54.1.4 A water cooler with a pressure vessel over 3 inches (76.2 mm) inside diameter, but not exceeding 3 cubic feet (0.08 m^3), internal gross volume, shall be protected by a pressure-relief device or fusible plug.

54.1.5 A water cooler with a pressure vessel exceeding 3 cubic feet (0.08 m^3), but less than 10 cubic feet (0.28 m^3) internal gross volume, shall be protected by a pressure-relief device.

54.1.6 There shall be no stop valve between the pressure-relief means and the parts or section of the system protected.

54.1.7 All pressure-relief devices shall be connected as close as practicable or directly to the pressure vessel or parts of the system protected. They shall be connected above the liquid refrigerant level, installed so that they are readily accessible for inspection and repair, and arranged so that they cannot readily be rendered inoperative.

54.1.8 Fusible plugs may be located above or below the liquid refrigerant level.

54.2 Required discharge capacity

54.2.1 Calculation of the minimum required discharge capacity and the rated discharge capacity of a rupture member or fusible plug shall be in accordance with the Safety Code for Mechanical Refrigeration, ASHRAE 15.

54.3 Relief valves

54.3.1 Pressure-relief valves shall comply with the requirements of Section VIII of the Boiler and Pressure Vessel Code, ASME. Valves of 1/2 inch iron pipe size (ips) and larger shall bear the authorized Code "UV" symbol together with the set pressure and capacity. Valves of less than 1/2 inch ips shall be similarly marked, except where the size does not accomodate a nameplate, the code symbol shall be omitted and the set pressure and capacity are to be stamped on the valve or on a metal plate attached to it. Manufacturers of valves which do not bear the Code symbol shall provide evidence of certification of the valve and its pressure and capacity ratings to code authorities.

54.3.2 Pressure-relief valves shall be sealed at a start-to-discharge pressure not exceeding the marked working pressure of the pressure vessel protected or not exceeding one-fifth of the ultimate strength of pressure vessels which do not have a marked working pressure.

54.3.3 The marked discharge capacity shall be not less than the minimum required discharge capacity as computed from 54.2.1.

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THERMOELECTRIC SYSTEM

55 General

55.1 A thermoelectric water cooler shall comply with requirements in this standard except for those specifically applying to vapor-compression refrigeration systems as outlined in Sections 24.3, 49 – 54, 57.1.2, 64, 65, 80, 81.1 – 81.4, 91, 92 as well as paragraphs 21.13, 62.2, 97.2(d), 97.2(e), 97.3 – 97.6, 97.10, 97.11 and 99.14.

55.2 Except as specified in 55.5, a thermoelectric water cooler in which the thermoelectric circuit is powered by:

a) An extra-low-voltage supply source shall not result in a risk of fire in accordance with 75.2.1.1 if no fan is provided or 75.2.1.2 if provided with fan(s).

b) A power source other than an extra-low-voltage supply shall not result in a risk of fire or electric shock in accordance with 75.2.1.1 if no fan is provided or 75.2.1.2 if provided with fan(s). In addition, the water cooler shall comply with 75.2.1.3.

55.3 In reference to 55.2, a thermoelectric water cooler that uses a fan, other than one that is thermally protected in accordance with 24.2.1(d), to cool the semiconductor thermoelectric module shall not develop temperatures exceeding 302°F (150°C) on the fan motor winding (open type) or on the fan motor enclosure (enclosed type) when tested in accordance with 75.2.3.1.

55.4 In reference to the nonmetallic material requirements in Section 8, a semiconductor thermoelectric module powered by other than an extra-low-voltage circuit shall be considered an ignition source.

55.5 In reference to 55.2(b), a thermoelectric water cooler not complying with 75.2.1.1 or 75.2.1.3 shall comply with 75.2.1.4.

WATER SYSTEM

56 General

56.1 A hot- and cold-type water cooler with an unvented hot-water storage tank, shall be provided with a pressure relief valve in accordance with 54.3 or have provision for the connection of a pressure-relief device during installation.

56.2 Parts of a pressure type water cooler that are exposed to water pressure shall be:

a) Made of copper or steel tubing complying with the wall thickness requirements of Table 51.1; or

b) Tested in accordance with 81.7.

PERFORMANCE

57 General

57.1 Instrumentation

57.1.1 Temperature measurements

57.1.1.1 Temperatures shall be measured by one of the following means:

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a) Thermocouples, or

b) The change in resistance method for the temperature of motor windings or of coils.

57.1.1.2 Thermocouples shall consist of 24 – 30 AWG (0.21 – 0.05 mm^2) wires.

57.1.1.3 Thermocouples and related instruments shall be accurate and calibrated.

57.1.1.4 Thermocouple wire shall conform to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

57.1.1.5 A thermocouple junction and adjacent thermocouple lead wire are to be held in positive thermal contact with the surface of the material whose temperature is being measured. In most cases, thermal contact will result from securely taping or cementing the thermocouples in place, but where a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

57.1.1.6 Except as specified in 57.1.1.7, during any test in which temperatures are measured, temperatures shall be monitored until maximum temperatures are attained. Thermal equilibrium is to be considered to exist when three successive readings indicate the same or decreasing temperatures. Readings shall be taken at the end of not less than three consecutive periods, the duration of each period being not less than 5 minutes.

57.1.1.7 In reference to 57.1.1.6, if temperatures on the component being monitored cycle between higher and lower temperatures due to the component cycling as part of the test (for example a load cycling on and off due to operation of a protective device), equilibrium is to be considered obtained when three successive peak temperatures indicate the same or decreasing temperatures.

57.1.1.8 In reference to 57.1.1.6 and 57.1.1.7, the recorded temperature shall be the highest of the three readings.

57.1.2 Pressure measurements

57.1.2.1 Pressure gauges are to be attached in such a manner as to prevent leakage. Special fittings for direct connection to the system or minimum lengths of 1/8 inch (3.2 mm) outside diameter commercial capillary tubing may be employed for gauge connections. The volume of the pressure-measuring gauge and lines is to be held to a minimum. All joints in the gauge system are to be tested for leakage.

57.1.2.2 Opening of the gauge line valves shall not cause a significant change in the electrical input of the system that would prevent the equipment from performing in its intended manner. High-side gauges and lines may be heated above the saturation temperature corresponding to the expected pressure or may be precharged with a liquid refrigerant of the same type as used in the system to minimize the effect of opening the gauge line valves.

57.2 Ambient temperature

57.2.1 Unless otherwise specified in an individual test method, the ambient temperature for the following tests shall be 77 ±3°F (25 ±2°C).

58 Tests on Nonmetallic Materials

58.1 General

58.1.1 Nonmetallic materials are to be evaluated as indicated in Table 58.1

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Table 58.1
Tests on nonmetallic materials – based on section 8.2

Nonmetallic component	Applicable test number
A part serving as an enclosure for ignition sources.	1[a], 2[a], 3[b] or 4[h], 5, 6[c], 7[d], 8, 9, 10, 11, 12, 13
A part serving as a cabinet.	Minimum 4[h], 5, 6[c], 7[d], 8, 9, 10, 11, 12, 13
A functional part.	Minimum 4[h], 5, 6[c], 7[d], 8, 9, 10, 11, 13
A nonfunctional part.	Minimum 4[h], 8

APPLICABLE TESTS

1. 5 inch end product flame test.[e]

2. 5V rated material.[f]

3. V-0, V-1, V-2, HF-1, HF-2 rated materials[f], 3/4 inch End Product Flame Test[e] or 12 mm End Product Flame Test.[e]

4. HB or HBF rated material[f] or a material with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.[g]

5. Mold Stress-Relief Test.[e]

6. Fastener Strength Test, 58.3.

7. Adhesive Test.[e]

8. Radiant Panel or Surface Burning Characteristic Test[g] – A flame spread index (FSI) of not more than 200 applies only to parts forming portions of the water cooler exterior surface, including any nonfunctional (e.g., decorative) part if the total area of all external parts exceeds 10 ft^2 (0.93 m^2). With respect to ASTM E162, if the Radiant Panel Test is conducted and any dripping of the part/material exceeds 10 drops during any 10 second period of time, the test shall not be considered invalid as long as sufficient material remains to enable calculating the flame spread index.

9. Volume Resistivity Test[e] – Applies only if electrical spacings between uninsulated live parts and the material are less than specified in line-voltage circuits, and extra-low voltage (Class 2) circuits, or if the part is used as indirect support of an uninsulated live part.

10. High Current Arc Resistance to Ignition Test[e] – Applies only if the material is used to enclose uninsulated live parts or to provide indirect support of uninsulated live parts. The test does not apply if uninsulated live parts are located a minimum of 1/32 inch (0.79 mm) from the part. If applicable, no ignition shall occur to V-0 materials subjected to 15 arcs; to V-1, V-2, or 5V materials subjected to 30 arcs, or to HB materials subjected to 60 arcs.

11. Hot Wire Ignition Test[e] Applies only if the material is within 1/2 inch (12.7 mm) of electrically-heated wires or resistors. If applicable, ignition shall not occur in less than 10 s for V-0 materials, 15 s for V-1 or 5V materials or 30 s for V-2 or HB materials.

12. Impact Tests[e] 5 ft-lb (6.8 J) impact for enclosures containing uninsulated live and hot parts, 1.5 ft-lb (2.0 J) impact for enclosures containing moving parts.

13. Ultraviolet Light Exposure Test[e] – Applies to a water cooler having a lamp emitting ultraviolet (UV) radiation in which the nonmetallic part(s) could be exposed to the UV lamp radiation.

[a] An enclosure provided with a barrier interposed between the material and an ignition source will be tested with the barrier in place.

[b] A material with a V-2 or HF-2 minimum rating is able to be used to enclose an ignition source if the ignition source is only energized as a result of a continuous action by an attending operator.

[c] Applies to an enclosure that serves only to reduce the risk of electric shock and having ultrasonic welds; heat welds; polymeric screws or nuts; metal screws threaded into a polymeric part or other means where degradation of a polymeric material affects securement.

[d] Applies only if the adhesive is relied on to maintain the integrity of an enclosure or functional part.

[e] Tested or rated as described in UL 746C.

[f] Tested or rated as described in UL 94.

[g] Tested or rated as described in ASTM E162 or UL 723.

[h] These materials are able to be used if ignition sources are separated or isolated in accordance with 8.2.1 – 8.2.3.

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58.2 Burnout test – Impedance protected motors

58.2.1 An impedance protected motor not provided within an enclosure and located adjacent to nonmetallic materials other than those rated 5V, shall comply with 58.2.2 or 58.2.7.

58.2.2 There shall be no ignition of cotton surrounding the motor when tested as described in 58.2.3 – 58.2.6.

58.2.3 One sample motor shall be arranged for testing as follows:

a) At least one thermocouple shall be secured to the winding for measurement of the winding temperature.

b) The rotor shall be locked.

c) The motor shall be mounted as intended in use.

d) The motor shall be completely wrapped in dry absorbent surgical cotton.

e) The motor shall be connected to a variable voltage source.

58.2.4 The motor shall be energized at rated voltage and operated until the winding temperature stabilizes.

58.2.5 The voltage shall be progressively increased in 5-volt increments, allowing the winding temperature to stabilize after each increase in voltage.

58.2.6 Operation of the motor shall continue until burnout occurs.

58.2.7 There shall be no ignition of materials surrounding the motor when tested as described in 58.2.8.

58.2.8 The test shall be conducted as outlined in 58.2.3 – 58.2.6 with the difference that the motor shall not be wrapped in cotton and shall be mounted as intended within a complete unit.

58.3 Fastener strength test

58.3.1 With reference to the requirement in 8.3.1, nonmetallic fasteners that can degrade and affect the integrity of an enclosure shall comply with 58.3.2 and 58.3.3.

58.3.2 The tightening torque and pull-off strength of such fasteners shall be not less than 50 percent of the as-received value.

58.3.3 Three sets of samples, each set consisting of three specimens, shall be temperature conditioned as indicated in Table 58.2 and Table 58.3.

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Table 58.2
Test specifications

Sample set	No. of samples	Test specifications
1	3	As-received (no conditioning).
2	3	Oven aging – 300 hours at the service temperature plus 10°C (18°F) but not less than 70°C (158°F). Service temperature is considered to be the temperature measured during the Temperature and Pressure Test, Section 62.
3	3	Heat cycling – 40 cycles of alternate heating and cooling at the temperatures specified in Table 58.3. Each cycle is to consist of 4 hours at the upper temperature followed by 4 hours at the lower temperature.

Table 58.3
Temperature cycling parameters

Location	Upper temperature	Lower temperature
Nonrefrigerated Areas	Service temperature plus 10°C (18°F) but not less than 70°C (158°F)	25°C (77°F)
Refrigerated Area	32°C (90°F)	0°C (32°F)
Low Temperature Area	32°C (90°F)	minus 17.8°C (0°F)

59 Test Voltage

59.1 A water cooler shall be tested with the voltage at the water cooler supply connections maintained:

a) In accordance with Table 59.1 and at 60 Hz; or,

b) At rated voltage and frequency of the water cooler, if it is intended for other than 60 Hz.

Table 59.1
Test voltages

Nameplate voltage rating	Test voltage[a]
110 to 120	120
208	208
220 to 240	240
254 to 277	277
440 to 480	480
550 to 600	600

[a]These voltages are nominal for the Rain Test, Section 68, Condenser Fan Motor Failure Test, Section 64, and Condenser Water Failure Test, Section 65.

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60 Leakage Current Test – Cord Connected Water Coolers

60.1 The leakage current of a cord connected water cooler rated 250 volts or less when tested in accordance with 60.6 and 60.7 shall be no more than 0.75 milliamperes.

60.2 Leakage current refers to all currents, including capacitively coupled currents, which may be conveyed between exposed conductive surfaces of a water cooler and ground or other exposed conductive surfaces.

60.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered suitable for protection against shock hazard as defined in 9.4.2 and 9.4.3. Surfaces are 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 voltages which are considered to be low-voltage.

60.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil with an area of 3.9 by 7.8 inches (10 by 20 cm) in contact with the surface. Where the surface is less than 3.9 by 7.8 inches, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the

60.5 The measurement circuit for leakage current shall be as shown in Figure 60.1. The measurement instrument is defined in (a) – (c) and, unless it is being used to measure leakage from one part of a water cooler to another, the meter is to be connected between the accessible parts and the grounded supply conductor. The meter which is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all of the attributes of the defined instrument.

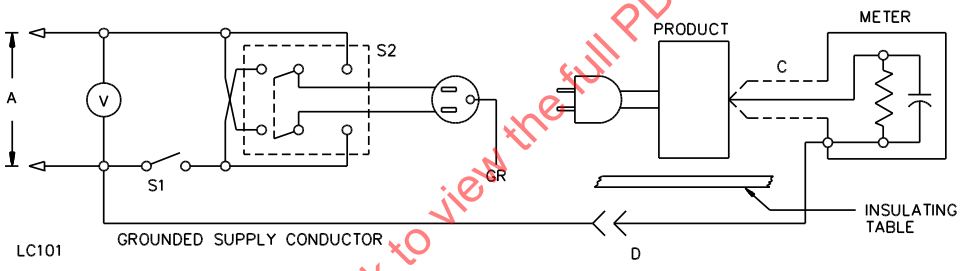
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

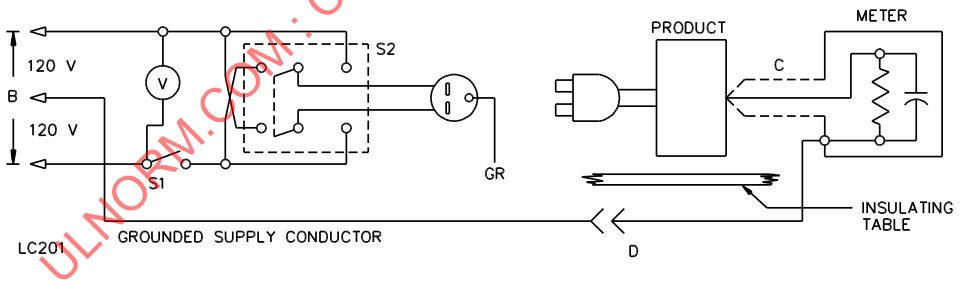
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15-microfarad capacitor to 1500 ohms. At an indication of 0.75 milliamperes, the measurement is to have an error of not more than 5 percent.

Figure 60.1

Leakage current measurement circuits



A. Product intended for connection to a 120 or 208 volt power supply.



B. 240- or 208-volt products intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

C. Probe with shielded lead – Under some circumstances where higher frequency components are present, shielding of measuring instrument and its leads may be necessary.

D. Separated and used as clip when measuring currents from one part of a product to another.

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60.6 A sample of the water cooler is to be prepared and conditioned for leakage current measurement as follows:

a) The sample is to be representative of the wiring methods, routing, components, component location, installation, and the like, of the production unit.

b) The grounding conductor is to be open at the attachment plug and the test water cooler isolated from ground.

c) The sample is to be conditioned in an ambient temperature of 70 – 80°F (21.1 – 26.7°C) and 50 ±5 percent relative humidity for not less than 8 hours.

d) The test is to be conducted at the ambient conditions specified by (c).

e) The supply voltage is to be adjusted to the voltage indicated in 59.1.

f) Water lines and water storage tanks are to be filled with water.

g) Water coolers employing water-cooled condensers are to be tested with water flowing through the condenser at the rate required for operation of the system.
Note – Caution should be exercised to avoid grounding the unit through water connections.

60.7 The leakage current test sequence, with reference to the measuring circuit of Figure 60.1, is to be as follows. During any of the following tests, if the compressor stalls during positioning of switch S2, the test is to be conducted in its entirety in one polarity. The polarity is then to be reversed and the test repeated.

a) With switch S1 open, the water cooler is to be connected to the measurement circuit. Leakage current shall be measured using both positions of switch S2. All manual switching devices shall then be operated in their normal manner, and leakage currents will be measured using both positions of switch S2.

b) With the water cooler switching devices in their normal operating position, switch S1 shall then be closed, energizing the water cooler, and within a period of 5 seconds, the leakage current shall be measured using both positions of switch S2. All manual switching devices shall then be operated in their normal manner, and leakage currents measured using both positions of switch S2.

c) The water cooler switching devices are then to be returned to their normal operating positions and the water cooler allowed to run until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test, thermal equilibrium is defined as that condition where leakage current is found to be constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement. Thermal equilibrium may involve cycling caused by an automatic control in the cooling and heating mode. This cycling shall be observed in both positions of switch S2.

d) Immediately following the above test, any single-pole switch or thermostat on the water cooler is to be opened, and the leakage current monitored until constant or decreasing values of leakage current are recorded. Readings are to be taken in both positions of switch S2.

61 Input Test

61.1 The measured ampere input to a cord connected water cooler shall not exceed the total rating marked on the water cooler nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 62.

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Exception: For a battery-operated water cooler, the input is to be measured with the water cooler in the charging mode during the Temperature and Pressure Test after operating for five minutes. The battery is to be fully discharged in accordance with the battery manufacturer's instructions at the start of the test.

61.2 The measured input to a permanently connected water cooler shall not exceed the individual rating of each load or group of loads or the total rating as marked on the nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 62.

61.3 The test sample is to be operated with all loads operating, including accessories, until stabilized input conditions are obtained.

61.4 If an accessible 15 or 20 ampere receptacle is provided on a water cooler, the water cooler measured ampere input shall be increased by an amount equal to 80 percent of the receptacle rating.

62 Temperature and Pressure Test

62.1 The temperature rises measured on the components of a water cooler shall not exceed those specified in Table 62.1.

Table 62.1
Maximum temperature rises

Device or material	°C	(°F)
A. MOTORS		
1. Class A insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including hermetic motor-compressors)[a]		
a. In open motors –		
Thermocouple or resistance method	75	(135)
b. In totally enclosed motors –		
Thermocouple or resistance method	80	(144)
2. Class A insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) (not including hermetic motor-compressors)[b]		
a. In open motors –		
Thermocouple method	65	(117)
Resistance method	75	(135)
b. In totally enclosed motors–		
Thermocouple method	70	(126)
Resistance method	80	(144)
3. Class B insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including hermetic motor-compressors)		
a. In open motors –		
Thermocouple or resistance method	95	(171)
b. In totally enclosed motors –		
Thermocouple or resistance method	100	(180)
4. Class B insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) (not including hermetic motor-compressors)		
a. In open motors –		

Table 62.1 Continued on Next Page

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Table 62.1 Continued

Device or material	°C	(°F)
Thermocouple method	85	(153)
Resistance method	95	(171)
b. In totally enclosed motors –		
Thermocouple method	90	(162)
Resistance method	100	(180)
B. COMPONENTS		
1. Capacitors		
Electrolytic type[c]	40	(72)
Other types[d]	65	(117)
2. Field wiring	35	(63)
3. Hermetic motor compressor enclosures[e]	150	(302)
4. Relay, solenoid, and, other coils (except motor coil windings) with:[b]		
a. Class 105 insulated winding –		
Thermocouple method	65	(117)
Resistance method	85	(153)
b. Class 130 insulation –		
Thermocouple method	85	(153)
Resistance method	105	(189)
5. Solid contacts	65	(117)
6. Transformer enclosures – with		
a. Class 2 transformers	60	(108)
b. Power transformers	65	(117)
7. Wood or other flammable material	65	(117)
C. INSULATED CONDUCTORS		
1. Flexible cords and wires with rubber, thermoplastic, or neoprene insulation unless recognized as having special heat-resistant properties as follows:		
Temperature rating		
°C (°F)		
60 (140)	35	(63)
75 (167)	50	(90)
80 (176)	55	(99)
90 (194)	65	(117)
105 (221)	80	(144)
D. SURFACES[e]		
1. Surfaces of water cooler at points of zero clearance to test enclosure	90	(194)
2. Surfaces of test enclosure where clearance to flammable material is specified	90	(194)
3. Surfaces of water cooler contacted by persons in operating it (control knobs, pushbuttons, levers, and the like)		
Metal	60	(140)
Nonmetallic	85	(185)

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Table 62.1 Continued on Next Page

Table 62.1 Continued

Device or material	°C	(°F)
4. Surfaces of water cooler subjected to casual contact by persons (enclosure, grille, and the like)		
Metal	70	(158)
Nonmetallic	90	(194)
E. ELECTRICAL INSULATION – GENERAL		
1. Fiber used as electrical insulation or cord bushings	65	(117)
2. Phenolic composition used as electrical insulation or as parts where a failure will result in a hazardous condition	125	(225)
3. Thermoplastic material. Rise based on temperature limits of material.	–	–

[a] Thermocouple applied directly to the integral insulation of the coil conductor.

[b] Thermocouple applied as in (1) or applied to conventional coil wrap.

[c] For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure may be not more than 65°C (117°F).

[d] A capacitor which operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.

[e] Tabulated temperatures for surfaces indicated in subitems 1, 2, 3, and 4 of item D are maximum temperatures – not temperature rises.

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62.2 The maximum pressure developed in a water cooler tested as described in 62.3 – 62.13, shall be used as a basis for the requirements of the Strength Tests – Pressure Containing Components, Section 81.

62.3 The water cooler is to be installed in accordance with the manufacturer's instructions, see 6.1 and 6.2, and operated under the conditions specified in 62.4 – 62.13, as applicable. The test potential is to be as indicated in 59.1.

62.4 For the tests specified in 62.5, 62.6, 62.10, 62.11, and 62.13, the water cooler shall be shielded from forced air currents, within the test room, having velocities that exceed 50 ft/min (0.25 m/s).

62.5 A water cooler of the built-in type is to be tested with the appliance placed within a test alcove or equivalent test setup to simulate actual conditions of use. The test alcove or equivalent test setup is to consist of 3/8-inch (9.5-mm) thick plywood placed closely around the cooler and/or in accordance with the installation instructions, but in no case shall the clearance between normally enclosed surfaces of the unit and the test enclosure exceed 1 inch (25.4 mm). Units designed to receive and discharge ventilating air are to use the manufacturer's grills provided with the unit.

62.6 A water cooler of the wall-hung or against-the-wall type is to be tested with the unit placed near or against a simulated wall in accordance with the installation instructions if proximity to the wall will affect operation of the unit.

62.7 The assembly is to "pulldown" under the following test conditions. Pulldown will be effected when the assembly runs continuously at approximately constant electrical input and low-side pressure. An automatic-reset protective device may cycle provided pulldown is obtained within 8 hours. A manual-reset protective device shall not trip during the starting or operating period.

62.8 For this test, a representative water cooler is to be fitted with pressure gauges on the high- and low-pressure sides of the refrigeration system. Thermocouples are to be secured to various surfaces and electrical components, including the compressor-motor enclosure, fan-motor windings, starting-relay coil, capacitors, and wiring insulation. The temperature of motor windings or of coils may be measured by the

resistance method, but the primary method of temperature measurement is to be the thermocouple method. The electrical input is to be measured with voltmeter and ammeter. The cold-water thermostat is to be electrically bypassed or shunted during the test.

62.9 The test conditions to be maintained during the Temperature and Pressure Test are as shown in Table 62.2.

Table 62.2
Test conditions

	°F	(°C)
Bottle-type cooler		
Ambient temperature	104	(40)
Drinking water in	104	(40)
Test flow rate (minimum)	1 gph (3.8 liters/hour)	
Pressure-type cooler – air cooled[a]		
Ambient temperature	104	(40)
Drinking water in	80	(26.7)
Drinking water out	60	(15.6)
Pressure-type cooler – water cooled[a]		
Ambient temperature	Convenient	
Drinking water in	80	(26.7)
Drinking water out	60	(15.6)
Condenser water in	80	(26.7)
Condenser water out	100[b]	(37.8)
Hot- and cold-type cooler	c	

[a] See 62.11 or 62.12.

[b] Where this condition cannot be attained due to design, the unit is to be tested at 80°F (26.7°C) inlet condenser water temperature and 35 psig (0.24 MPa) nominal pressure.

[c] Heating system operated concurrently as described in 62.13 while cooling system operated under the conditions specified above.

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62.10 In testing a bottle-type water cooler, the cooler and the filled bottle are to be brought to room temperature 104°F (40°C), and the cooler then started and run continuously until constant temperature and pressure conditions are reached. During the test, water is to be drawn continuously at the specified flow rate.

62.11 In testing an air-cooled, pressure type water cooler, the unit is to be placed in a room maintained at 104°F (40°C) for a period of not less than 4 hours, then started and run continuously. Inlet water is to be maintained at 80°F (26.7°C), 35 psig (0.244 Pa) (nominal). There is to be complete diversion of spillage from the precooler. The drinking water flow rate is to be established by adjusting the flow through the unit to provide 60°F (15.6°C) outlet water. This flow rate will be considered stabilized if, after at least 2 hours of operation, the average of four subsequent outlet-water temperature measurements taken at 15-minute intervals, is 60 ±1°F (15.6 ±0.6°C) and provided each of the four readings is within the range of 58 – 62°F (14.4 – 16.1°C). Water temperature measurements are to be made as near as practicable to the inlet and outlet fittings of the water cooler. After the above preliminary flow rate has been established, the unit is to be de-energized and permitted to come to room temperature. It is then to be restarted and operated continuously with the water-flow rate set at the value obtained above, except for minor adjustments necessary to provide 60°F (15.6°C) outlet water under stabilized conditions during the input and temperature-pressure tests.

62.12 A water-cooled, pressure-type water cooler is to be operated at an ambient temperature of 77±3°F (25±2°C) with the condenser water controlled as specified in 62.9. A preliminary flow rate for potable water is to be established and the test conducted as indicated in 62.11.

62.13 In testing a water cooler of the hot-and-cold type, the hot water temperature regulating control is to be set in the hottest position, and the heating system is to be energized concurrently with the cooling system operating in accordance with 62.10 or 62.11. The water heater is to be operated until the temperature regulating control opens, at which time one-fourth of the water is to be drawn off and replaced from the supply. The water heater shall be allowed to heat again until the temperature regulating control opens, at which time component temperatures shall be measured.

62.14 The water cooler is to comply with the Dielectric Voltage-Withstand Test, Section 63, following the foregoing tests.

63 Dielectric Voltage-Withstand Test

63.1 A complete water cooler and all electrical components shall be capable of withstanding for a period of 1 minute, without breakdown, a test potential applied between high-voltage live parts and dead metal parts and between high-voltage live parts and extra-low-voltage circuits as follows:

a) For ac circuits - Any frequency between 40 and 70 hertz with a test potential of:

1) 1000 volts for any motors not rated over 250V, 1/2 horsepower (373 W output);

2) 1000 volts plus twice rated voltage; and,

3) 1000 volts plus twice the developed capacitor voltage for any motor circuit in which the steady-state voltage developed through the use of capacitors exceeds 500 volts, as determined during the Temperature and Pressure Test, Section 62.

b) For dc circuits – A test potential of:

1) 1400 volts for any motors not rated over 250V, 1/2 horsepower (373 W output); and,

2) 1400 volts plus 2.8 times rated voltage.

63.2 A water cooler employing an extra-low-voltage circuit shall be capable of withstanding for 1 minute, without breakdown, the specified test potential applied between low-voltage live parts and dead metal parts. The test potential shall be:

a) A dc potential of 700 V; or

b) An ac potential of 500 V at any frequency between 40 and 70 Hz.

63.3 In reference to 63.2, if components specified in 47.3 are employed in the extra-low-voltage circuit, the dielectric voltage-withstand test, shall be:

a) Conducted on the components with the dielectric potential applied between live parts of opposite polarity; or

b) The components shall be separately subjected to the dielectric voltage-withstand test.

63.4 In reference to 63.3, the test between extra-low-voltage parts of opposite polarity shall be conducted on magnet coil windings of the transformer after breaking the inner coil lead where it enters the layer.

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63.5 In determining whether a product complies with 63.1 and 63.2, the dielectric potential shall be applied by:

a) A 500 volt-ampere or larger transformer; or

b) Test equipment that maintains the specified high potential voltage at the product during the duration of the test.

63.5.1 The applied dielectric potential specified in 63.1 and 63.2 shall be increased gradually from zero until the required test value is reached and shall be held at that value for 1 minute.

63.6 If the charging current through a capacitor or capacitor or capacitor-type filter connected across the line, or from line to earth ground, is large enough to make it impossible to maintain the required alternating-current test potential, the capacitors and capacitor-type filters may be tested as described in the next paragraph.

63.7 The capacitors and capacitor-type filters mentioned in the previous paragraph are to be subjected to a direct-current test potential of 1414 volts for equipment rated 250 volts or less or 1414 volts plus 2.828 times the rated circuit voltage for equipment rated at more than 250 volts. The direct-current test potential is to be maintained for 1 minute without breakdown.

63.8 Components providing a d.c. path in parallel with the insulation to be tested, such as discharge resistors for filter capacitors and voltage limiting devices (transient voltage suppressors), may be disconnected during the test.

64 Condenser Fan Motor Failure Test

64.1 A water cooler shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in (a) and (b), below, if the condenser fan motor locks or fails to start.

a) The refrigeration system shall not rupture or develop leaks during the test. The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 81. An assembly employing a pressure-limiting device conforming with 53.2, as applicable, is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure, of the fan motor winding (open type) or of the fan motor enclosure (enclosed type) shall not exceed 302°F (150°C). Compressors and condenser fan motors equipped with thermal protective devices as specified in Motors and Motor Overload Protection, Section 23, are considered to comply with this requirement.

64.2 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure and condenser fan motor winding (open type) or condenser fan motor enclosure (enclosed type). When evaluating low-side components for compliance with the strength requirements of 81.3, a pressure-gauge is to be fitted on the low-side of the system. The low-side pressure is to be recorded while the compressor is operating and after shutdown. If the water cooler is provided with means to relieve discharge pressure into the low-side of the system, the low-side pressure is to be recorded while:

a) The compressor is operating, the pressure relief means is open and the low-side pressure is increasing and

b) After shutdown of the compressor.

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The controls are to be set for maximum cooling and the water cooler is operated with the condenser fan motor locked until stabilized temperatures and pressures are reached. The compressor motor overload device and/or the fan motor overload device may operate during this test. The potential is maintained as indicated in 59.1. Where two or more condenser fan motors are employed, the test is to be conducted with one motor locked.

65 Condenser Water Failure Test

65.1 A water-cooled water cooler shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in (a) and (b), below, during water failure.

a) The refrigeration system shall not rupture or develop leaks during the test. The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 81.

b) The maximum temperature of the compressor enclosure shall not exceed 302°F (150°C). Compressors equipped with a thermal protective device(s) as specified in Motors and Motor Overload Protection, Section 23, are considered to comply with this requirement.

65.2 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure. When evaluating low-side components for compliance with the strength requirements of 813, a pressure gauge is to be fitted on the low side of the system. The low-side pressure is to be recorded as specified in 64.2. The water cooler is to be operated with the condensing water shut off and also with the condensing water restricted until maximum stabilized temperatures are reached or until representative maximum temperatures are attained under cycling load. If the water cooler cycles on a motor-overload protective device, the test is to continue until the maximum pressure during the protective device operation is obtained. The potential is to be maintained as indicated in 59.1.

65.3 The test is not to result in damage to electrical parts.

65.4 The test need not be conducted to determine compliance with 65.1 if a pressure-limiting device is provided. The maximum cutout pressure to which the pressure-limiting device may be readily adjusted by the adjusting means provided shall be employed in determining compliance with 65.1. See 81.4.

66 Overflow Test

66.1 With reference to 9.4.8, a water cooler in which water may overflow shall not allow the water to wet live parts or the windings of motors or coils.

66.2 The water cooler is to be positioned as intended in operation and any drains provided in drain basins, water reservoirs and/or waste water receptacles are to be blocked. The basin, reservoir or receptacle is to be filled to its capacity:

a) For bottle type water coolers, water is then to be added at a rate of 1 ounce per second (0.030 L/s) until the overflowing water accumulates in the bottom of the unit or on the floor beneath it.

b) For pressure type water coolers the water line pressure is to be set at the maximum allowed water pressure, per installation instructions, and then opened fully until the overflowing water accumulates in the bottom of the unit or on the floor beneath it.

66.3 Compliance with 66.1 is to be determined by visual examination, except that where visual examination is not practical, an insulation resistance and dielectric voltage withstand test is to be conducted immediately after overflow has occurred. The water cooler shall have an insulation resistance

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of not less than 50,000 ohms measured between current carrying parts and noncurrent carrying parts and shall comply with requirements of the Dielectric Voltage-Withstand Test, Section 63.

67 Spill Test

67.1 External spillage of liquid on a bottle type water cooler shall not result in wetting of uninsulated live parts or film-coated wire in line-voltage circuits. See 9.4.9.

67.2 The water cooler is to be positioned as intended in use. Four hundred-forty four millimeters (15 oz) of water are to be poured on the top surface of the unit and at a rate of approximately 30 mL/s (1 oz per second).

67.3 Compliance with 67.1 shall be determined within 30 minutes after the water is poured on the top of the water cooler by visual examination, dielectric voltage-withstand, or insulation resistance, except that windings of motors that are exposed to spillage shall:

a) Have an insulation resistance of not less than 50,000 ohms; and

b) Comply with the Dielectric Voltage-Withstand Test, Section 63.

68 Rain Test

68.1 A water cooler exposed to weather shall be subjected to a rain exposure without creating a risk of electric shock, see 68.4, due to current leakage or insulation breakdown.

68.2 The water cooler is to be installed in accordance with the manufacturer's instructions and subjected to the rain exposure under conditions most likely to cause entrance of water into or on the electrical components. The duration of exposure is to be 1 hour.

68.3 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 68.1. Spray heads are to be constructed in accordance with the details shown in Figure 68.2. The water pressure for all tests is to be maintained at 5 psig (34 kPa) at each spray head. The distance between the center nozzle and the water cooler is to be approximately 5 feet (1.5 m). The water cooler is to be brought into the focal area of the three spray heads in such a position and under such conditions that the greatest quantity of water will enter it. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to current carrying parts. The water cooler is to be operated so that electrical components are energized.

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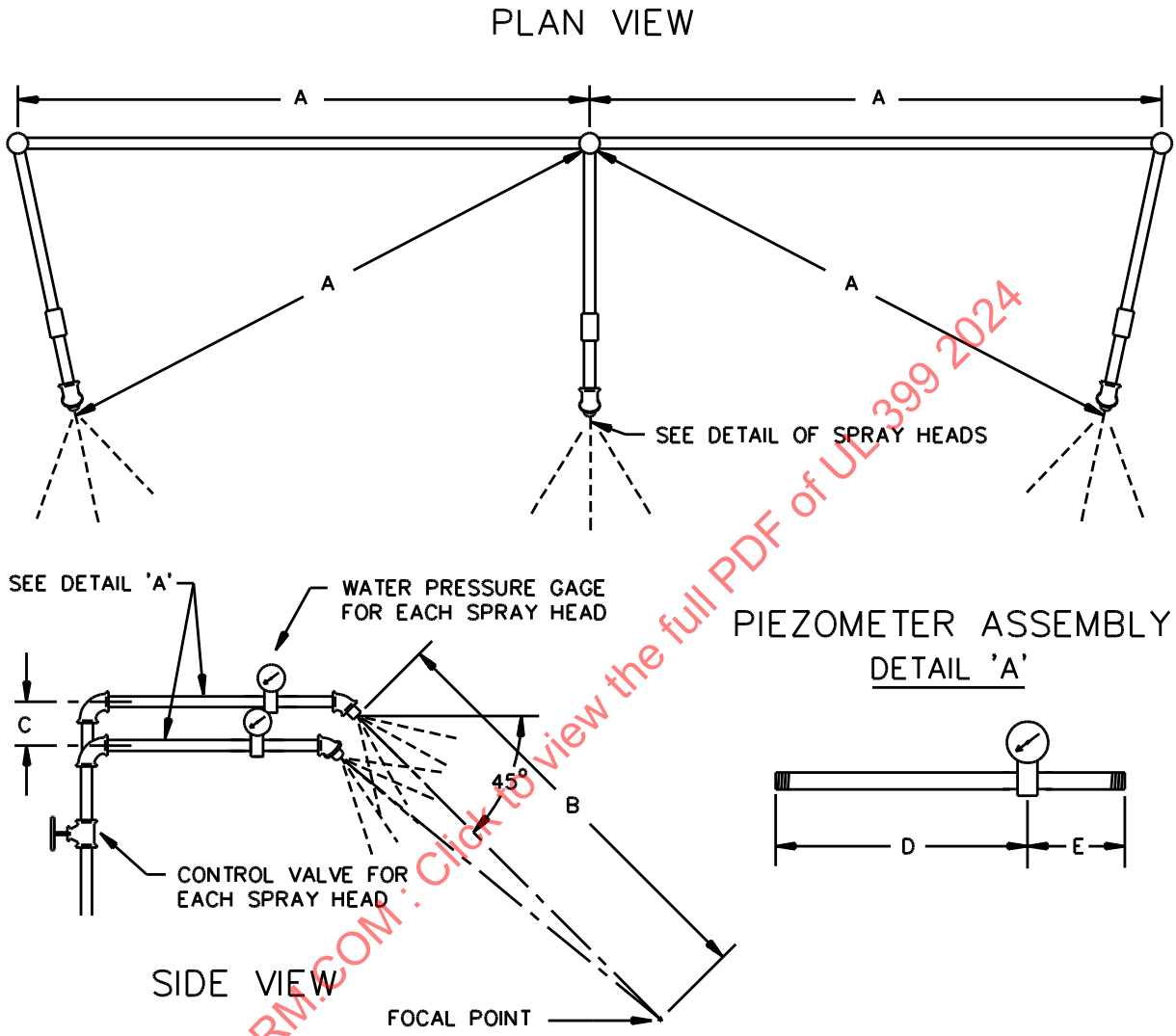
Figure 68.1

Rain-test spray-head piping



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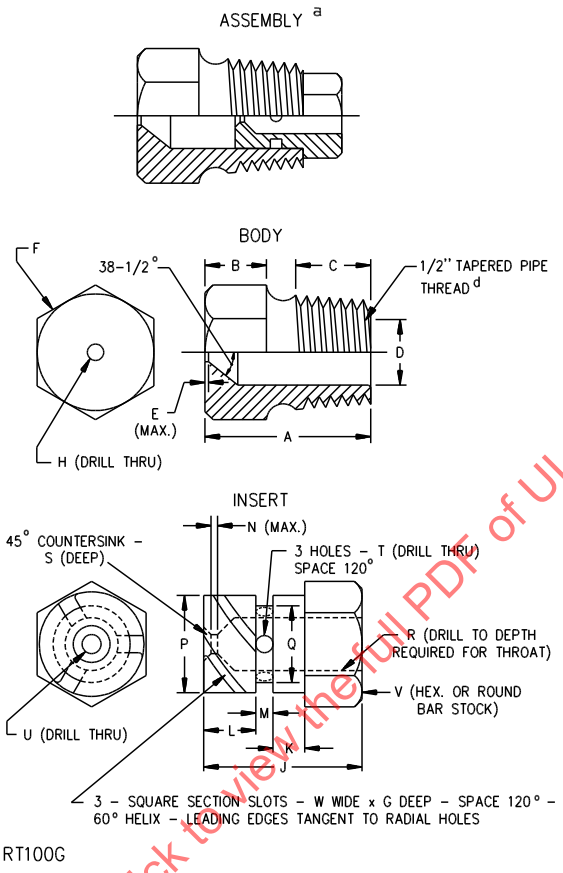
Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101E

Figure 68.2

Rain-test spray head



Item	inch	(mm)	Item	(inch)	(mm)
A	1-7/32	(31.0)	N	1/32	(0.80)
B	7/16	(11.0)	P	.575	(14.61)
C	9/16	(14.0)		.576	(14.63)
D	.578	(14.68)	Q	1453	(11.51)
	.580	(14.73)		454	(11.53)
E	1/64	(0.40)	R	1/4	(6.35)
F	c	c	S	1/32	(0.80)
G	.06	(1.52)	T	No. 35[b]	(2.80)
H	No. 9[b]	(5.0)	U	No. 40[b]	(2.50)
J	23/32	(18.3)	V	5/8	(16.0)
K	5/32	(3.97)	W	0.06	(1.52)
L	1/4	(6.35)			
M	3/32	(2.38)			

[a] Nylon Rain-test spray heads are available from Underwriters Laboratories

[b] ASME B94.11 (1993), Twist Drills

[c] Optional – To serve as a wrench grip

[d] ASME B1.20.1 (1983) (R1992), Pipe Threads, General Purpose (Inch).

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68.4 Following the rain test exposure, the water cooler shall have an insulation resistance of not less than 50,000 ohms measured between current carrying parts and noncurrent carrying parts, and shall withstand the Dielectric Voltage-Withstand Test, Section 63. The assembly shall also comply with 68.5 after the test.

68.5 The test is not to result in the entrance of water into enclosures above the lowest live part or in the wetting of live parts, except as follows:

a) Motor windings may be judged on the basis of the insulation resistance and by the Dielectric Voltage-Withstand Test, Section 63, provided the motors are within the cabinet and are shielded from openings in the top of the cabinet.

b) Water may enter an enclosure above the lowest live electrical part providing the point of entrance is not in proximity to live electrical parts and live parts are not wetted during the rain exposure.

69 Stability Test

69.1 A freestanding water cooler shall be stable and not overturn when placed on a plane surface inclined at an angle of 10 degrees when tested in accordance with 69.2.

69.2 The water cooler is to be supported by its base including any legs or leveling screws which may be provided. Other means of support, such as plumbing connections or conduit connections, shall not be relied on for the purpose of the test. If leveling screws are provided, they are to be adjusted equally to raise the unit to the maximum height permitted but not more than 1 inch (25.4 mm) above floor level. The unit is to be tested empty and if it is provided with any doors, they are to be closed.

70 Static Loading Test

70.1 A wall-hung water cooler and a column mounted water cooler shall withstand the test described in 70.2 without:

a) Collapse of the mounting means and

b) Severance of its securement to the mounting means when fastened to a wall or column, as applicable.

70.2 A representative water cooler is to be installed with its mounting hardware in accordance with the manufacturer's instructions. A load equal to three times the weight of the unit, acting vertically downward, is to be applied uniformly to the water cooler.

70A Cabinet/Enclosure Static Load Test

70A.1 This test is applicable if a water cooler sheet metal cabinet or enclosure is thinner than that specified in 12.1.11.

70A.2 A water cooler cabinet or enclosure constructed of sheet metal shall withstand the testing in 70A.3 – 70A.5 without any of the following occurring:

a) Damage to the refrigeration system as evidenced by release of refrigerant;

b) Reduction of electrical spacings below those specified in:

1) High-voltage circuits, Section 46;

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2) Extra-low voltage circuits, Section 47; or

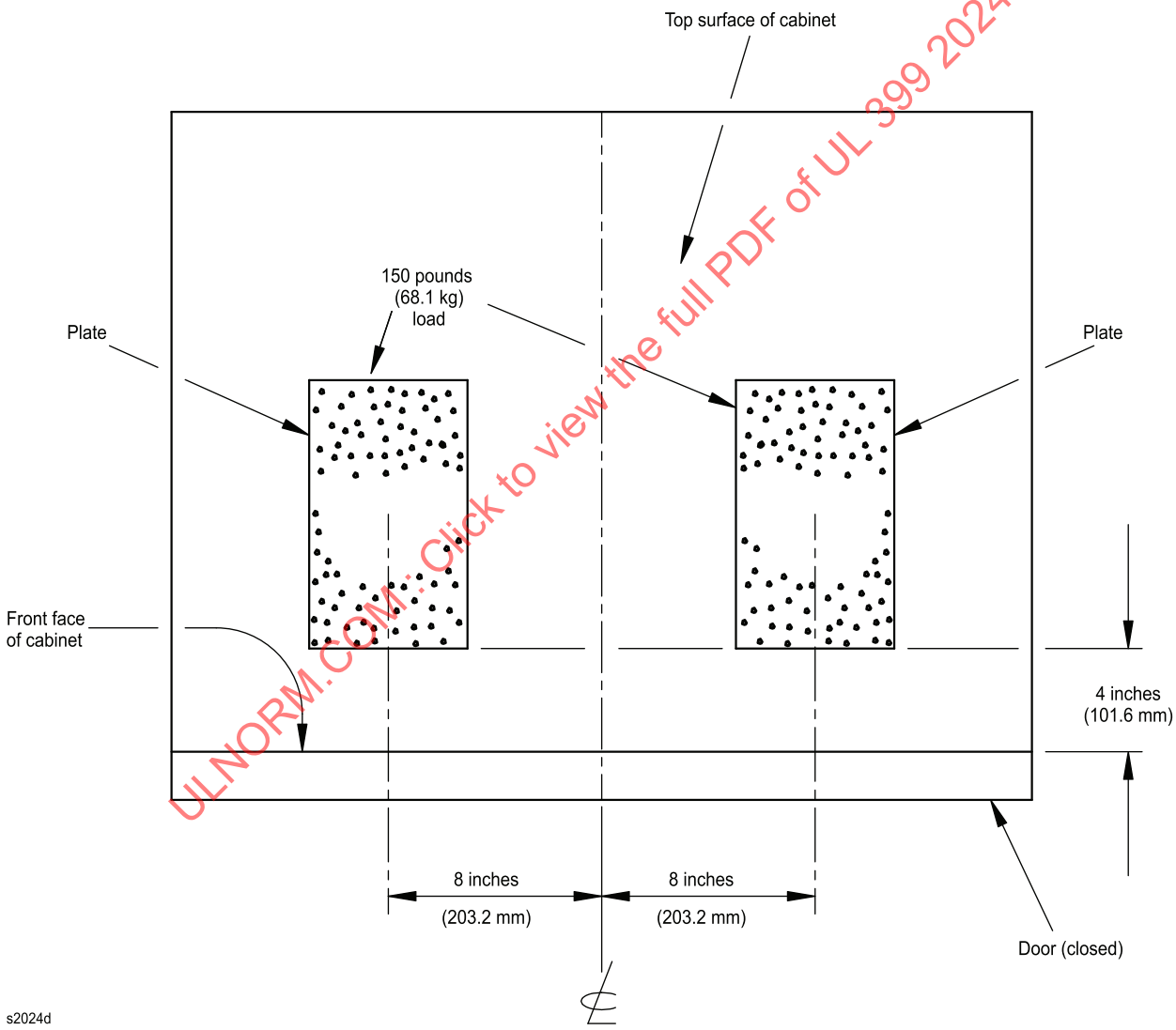
3) Alternate Spacings, Section 48;

c) Exposure of moving or electrically live parts such that the water cooler fails to comply with Mechanical Protection, Section 9.3 and Electrical Protection, Section 9.4; and

d) Reducing the insulating properties of internal wiring such that the water cooler fails to comply with the Dielectric Voltage-Withstand Test, Section 63.

Figure 70A.1

Cabinet/enclosure static load test arrangement



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70A.3 A load of 150 lbf (667 N) is to be simultaneously applied for a period of 5 minutes to each of two flat metal plates. The plates are to be 4 in. (101.6 mm) wide, 10 in. (254 mm) long, and not less than 1/8 in. (3.2 mm) thick. The plates are to be positioned with the major axes parallel to each other and to the sides of the cabinet or enclosure and applied to the surface of the water cooler:

a) As shown in Figure 70A.1;

b) Such that the outside of the edge of each plate is flush with the side of the cabinet or enclosure, if the width of the water cooler is less than 20 in (508 mm); or

c) Using another equivalent arrangement of the plates to simulate the static load being applied to the water cooler.

70A.4 In reference to 70A.3, the load shall be applied to the water cooler surface considered most likely to support a static load when the water cooler is in its intended mounting position.

70A.5 After the application of the test load as specified in 70A.3, the water cooler shall be subjected to the Dielectric Voltage-Withstand Test, Section 63.

70B Cabinet/Enclosure Impact Test

70B.1 A water cooler sheet metal cabinet or enclosure thinner than that specified in 12.1.11 and used to isolate uninsulated live parts shall comply with 70B.2 following the testing in 70B.3 – 70B.6.

70B.2 A water cooler sheet metal cabinet or enclosure shall withstand one of the impacts specified in 70B.3 without denting, breaking, or cracking in a manner that would:

a) Reduce electrical spacings below those specified in:

1) High-voltage circuits, Section 46;

2) Extra-low voltage circuits, Section 47; or

3) Alternate Spacings, Section 48;

b) Expose mechanically moving parts such that the water cooler fails to comply with Mechanical Protection, Section 9.3, and

c) Expose electrically live parts such that the water cooler fails to comply with Electrical Protection, Section 9.4.

70B.3 The impact shall be one of the following:

a) 5 ft-lb (6.8 J) if the cabinet or enclosure is used to protect against reduction in electrical spacings or exposure of electrically live parts in accordance with 70B.2 (a) or (c);

b) 1.5 ft-lb (2.0 J) if the cabinet or enclosure is used to protect against reduction in electrical spacings or exposure of electrically live parts in accordance with 70B.2 (a) or (c) and if the cabinet or enclosure is additionally located on the water cooler so that an impact due to an external force is unlikely; or

c) 1.5 ft-lb (2.0 J) if the cabinet or enclosure is used to protect against exposure of mechanically moving parts in accordance with 70B.2(b).

70B.4 The impacts shall be produced by a 2 in (50.8 mm) diameter, 1.18 lbm (0.54 kg) steel ball. The ball shall be either swung through an arc as a pendulum or allowed to fall freely to produce the impact.

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70B.5 Three complete as-received samples shall be used for this test with a single impact directed at a different location on each sample, except that fewer samples may be used if the sample can withstand repeated impacts.

70B.6 Each sample shall be impacted in its intended mounting position.

71 Ozone Test

71.1 A drinking water cooler equipped with ozone generating equipment shall not produce a concentration of ozone exceeding 0.05 parts per million by volume when tested as described in 71.2 – 71.7.

71.2 The test is to be performed in a room having a volume of 950 – 1100 ft^3 (26.9 – 31.1 m^3) with a minimum side dimension of 8 ft (2.4 m) and a maximum height dimension of 10 ft (3.0 m) without openings. The test room walls and ceiling are to be covered with a sheet of polyethylene or aluminum. The floor is to be of a nonporous material such as vinyl tile or aluminum.

71.3 During the test, the test room is to be maintained at a temperature of 77 ± 3°F (25 ± 2°C) and a relative humidity of 50 ± 5 percent. Prior to the start of and immediately after this test, the ozone background level is to be measured with the appliance off. The background level average is to be calculated and subtracted from the maximum measurement during the test.

71.4 The water cooler with the ozone generating equipment installed as intended is to be located in the center of the test room floor such that the location where ozone is discharged from the water cooler is about 30 inches (762 mm) above the floor.

71.5 The ozone monitor sampling tube is to be located 2 inches (50.8 mm) from the ozone discharge opening of the appliance and is to point directly into the air stream. If the ozone discharges into a water tank that is open to the atmosphere, the sampling tube is to be located within 2 inches (50.8 mm) of the point where the maximum amount of ozone discharges from the water.

71.6 The emission of ozone is to be monitored for 24 hours to determine the concentration.

71.7 The test described in 71.2 – 71.6 is to be repeated if the emission of ozone could be affected by operating the water cooler or ozone generating equipment under one or more of the following conditions:

a) Fan(s) energized or de-energized;

b) Particle filter(s) removed;

c) Other similar component(s) operational or non-operational;

d) With or without water; and

e) Other conditions that may affect the emission of ozone from the water cooler.

72 Strain Relief Test

72.1 When a water cooler is tested in accordance with 72.2 – 72.5, there shall be no movement of the cord or wiring leads to indicate that stress is transmitted to internal connections and wiring.

72.2 A strain relief means for a power supply cord, including that for an externally-mounted accessory shall be subjected to a direct pull of 35 pounds-force (156 N). The force may be generated by suspending a 35 pound (15.9 kg) weight on the cord of the water cooler.

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72.3 A strain relief means for wiring leads intended for connection of field-installed supply conductors and power supply conductors of an internally-mounted accessory shall be subjected to a direct pull of 20 pounds-force (89 N). The force may be generated by suspending a 20 pound (9.1 kg) weight on the water cooler leads.

72.4 The force specified in 72.2 or 72.3 shall be applied so that the strain relief is stressed from any angle permitted by the construction of the water cooler.

72.5 The force shall be applied for not less than 1 minute.

73 Water Heating Protective Controls Tests

73.1 Endurance test

73.1.1 The testing specified in 73.1.2 – 73.1.7 applies to water heater protective controls required to be tested in accordance with 21.15.

73.1.2 A protective control for an electric water heater shall be capable of withstanding an endurance test under the load which it controls for the number of cycles indicated in 73.1.4. There shall be no electrical or mechanical failure of the control nor undue burning, pitting, or welding of the contacts.

73.1.3 The initial (as-received) opening temperature of a water heater protective control is to be determined in accordance with the Calibration Test specified in 73.2.2 – 73.2.5 prior to conducting the endurance test.

73.1.4 The number of endurance cycles for the test is to be as follows:

a) An automatic-reset protective temperature (limiting) control which opens only in response to abnormal temperature shall withstand 100,000 cycles of operation under load if its short-circuiting results in a hazard, as defined in 75.1.2 and 75.1.3. The test may be omitted if its short-circuiting does not result in such hazards.

b) A manual-reset protective temperature (limiting) control which opens only in response to abnormal temperature shall withstand 1000 cycles of operation under load plus an additional 5000 cycles without load. The test may be omitted if its short-circuiting does not result in a hazard, as defined in 75.1.2 and 75.1.3.

73.1.5 The test is to be conducted with the device connected either to the heater element load or to an equivalent noninductive load. The frame of the device is to be connected through a 15 ampere fuse to ground or to the grounded conductor of the supply circuit.

73.1.6 If the device "fails safe" in the open position before the end of the test, it is not to be considered a failure provided the "fail safe" feature is inherent in the design.

73.1.7 After the endurance test, a water heater protective control is to be subjected to the Calibration Test specified in 73.2.2 – 73.2.5 and the control initial (as-received) opening temperature is to be compared with the control opening temperature following the endurance test. The protective control shall comply with the calibration requirement in 21.19(c)(2).

73.2 Calibration test

73.2.1 A water heater temperature protective control not complying with the calibration requirements specified in 21.19(a) or (b) shall comply with 21.19(c) when tested as specified in 73.2.2 – 73.2.5.

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73.2.2 The calibration-verification tests on a water heater temperature protective control are to be performed on representative production samples that have been produced and calibrated within the same tolerances permitted in factory production. The set-point temperature declared by the manufacturer for the sample is to be the maximum for which the device is intended. The tests are to be performed in a manner that will provide a true and measurable sensing-element temperature.

73.2.3 Thermocouples are to be attached to the sensing element, on an adjacent identical element, or located in air adjacent to the element. Indication of cutout is to be obtained by a low-energy circuit of such value as to not provide a current assist, and the cutout temperature is to be determined as the average of two trials.

73.2.4 A protective temperature control is to be tested in accordance with one of the following:

a) Immersion-element type controls are to be tested with the element inserted into a circulating-water system; or

b) Other types of controls are to be mounted in an air oven having forced circulation of at least 100 feet (30.5 m) per minute, and designed so as to nullify the effects of radiation.

73.2.5 Prior to calibration verification, uniform temperatures of all parts of a control are to be maintained by holding the temperature approximately 20°F (11°C) below the set point until conditions of equilibrium have been established. The temperature is then to be raised at a rate of not more than 1.0°F (0.5°C) per minute until the control functions.

74 Overload and Endurance Test for Operating Controls

74.1 This test applies to switches or other similar devices functioning as operating (regulating) controls as required by 21.25(e)(2).

74.2 A switching device in a drinking water cooler shall perform acceptably when tested as specified in 74.3 – 74.8 for overload and endurance. There shall be no electrical or mechanical failure nor undue burning, pitting or welding of contacts, or striking of an arc to dead metal parts.

74.3 The tests on switching devices shall be conducted by:

a) Evaluating the switching devices within a water cooler in accordance with 74.4 and 74.6 by operating the water cooler to cause the switching devices to operate, using the normal switching device loads of the water cooler; or

b) Cycling the switching devices individually or collectively while controlling the loads as outlined in 74.5 – 74.7.

74.4 If the test in 74.3(a) is conducted, the:

a) Enclosure of the drinking water cooler shall be connected through a 30 ampere cartridge fuse to the electrical test circuit pole considered least likely to strike (arc) to ground;

b) Switching device shall be mounted as intended in service; and

c) Test cycling shall be as specified in 74.6 unless a slower rate is required by the design of the water cooler. A faster rate may be used if agreeable to all concerned.

74.5 If the test in 74.3(b) is conducted, the switching device shall be subjected to an overload test at the ambient temperature for which it is intended. The overload test shall consist of making and breaking the

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connected load for 50 cycles of operation, with 1 second ON and 9 seconds OFF. The current, power factor and voltage used for testing each type of load shall be as follows:

a) Noninductive load(s) – 150 percent of the total connected load current. The power factor shall be 1.0 and the voltage shall be as specified in 59.1;

b) One or more motors together with one or more other loads – 100 percent of the larger of the locked-rotor current, maximum operating current or maximum rated current of the largest motor plus 100 percent of the full load or maximum operating current of all other motors and/or other loads. The power factor shall be 0.4 – 0.5 and the voltage shall be as specified in 59.1;

c) One or more inductive loads, such as a transformer or ballast, with or without other noninductive or pilot duty loads – 100 percent of the total inductive and other noninductive/pilot duty loads. The power factor shall be 0.7 – 0.8 and the voltage shall be as specified in 59.1; or

d) One or more pilot duty loads, such as a coil within a relay or electric valve – 100 percent of the total connected pilot duty loads. The power factor shall not exceed 0.35 and the voltage shall be 110 percent of the value specified in 59.1.

74.6 A switching device shall be subjected to an endurance test at the ambient temperature for which it is intended. The endurance test voltage shall be as specified in 59.1 and the current shall be 100 percent of the total connected load current. The endurance test cycling shall consist of making and breaking the connected load for:

a) 6000 cycles of operation with 1 second ON and 9 seconds OFF for a switching device other than one used to control a motor-compressor; or,

b) 24,000 cycles of operation with 1 second ON and 9 seconds OFF followed by 6,000 cycles of operation with 1 second ON and 59 seconds OFF for a switching device used to control a motor-compressor.

74.7 For a switching device tested in accordance with 74.3(b), the power factor for the endurance cycling in 74.6 shall be as specified in 74.5 for each type of load.

74.8 At the conclusion of the tests in 74.3 – 74.7, each switching device shall be subjected to and comply with the Dielectric Voltage-Withstand Test, Section 63.

75 Burnout Test

75.1 Water heater

75.1.1 The water heater of a hot- and cold-type water cooler shall not result in a risk of fire or electric shock if operated dry.

75.1.2 A risk of fire is considered to exist if there is any emission of flame or molten metal from the water cooler or glowing or flaming of flammable material.

75.1.3 A risk of electric shock is considered to exist if the insulation resistance of the water cooler is less than 50,000 ohms.

75.1.4 Opening of the supply circuit fuse or opening of the heater element is not considered to be a failure if the risk of fire and electric shock does not exist. If the heater element opens, three samples are to be tested to determine that the heater is designed to function in this manner.

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75.1.5 The test is to be conducted with the water heater operating dry. If an automatic-reset type of temperature limiting control is used to protect the heater, the test is to terminate when the temperatures of components and materials such as conductor insulation, electrical insulation, thermal insulation, and flammable materials near the heater element have stabilized. If a manual-reset type of temperature limiting control is employed, the test is to terminate when the limit control opens the heater circuit. The temperature regulating control shall be shorted out of the circuit during this test.

75.1.6 If a replaceable thermal cutoff is employed, the test is to be conducted five times using different samples of the thermal cutoff in each test. The thermal cutoff is to open 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. During the test the enclosure is to be connected through a 3 ampere fuse to ground, and any thermally operated control devices in the heater circuit other than the thermal cutoff are to be short-circuited.

75.2 Thermoelectric water coolers

75.2.1 General

75.2.1.1 Except as specified in 75.2.1.4, a thermoelectric water cooler without a fan, when tested in accordance with 75.2.2.1 shall not:

a) Emit any flame or molten metal from the water cooler; or

b) Show any evidence of any glowing or flammable material within the water cooler.

75.2.1.2 A thermoelectric water cooler with fan(s), when tested in accordance with 75.2.3.1 shall not develop temperatures exceeding 302°F (150°C) on the fan motor winding of an open type motor or of the fan motor enclosure of an enclosed motor. In addition, the thermoelectric water cooler with fans shall not:

a) Emit any flame or molten metal from the water cooler; or

b) Show any evidence of any glowing or flammable material within the water cooler.

75.2.1.3 Except as specified in 75.2.1.4, a thermoelectric water cooler with a semiconductor thermoelectric module powered by other than an extra-low-voltage circuit shall comply with 75.2.4. No dielectric breakdown shall occur.

75.2.1.4 If the thermoelectric module is powered by other than an extra-low-voltage supply source and the tests specified in 75.2.1.1 and 75.2.1.3 are not conducted, the test in 75.2.5 shall be performed. No dielectric breakdown shall occur.

75.2.2 Thermoelectric water coolers without fans

75.2.2.1 Unless tested in accordance with 75.2.5, a thermoelectric water cooler without a cooling fan shall be connected to a supply circuit maintained as indicated in 59.1. Any heat sink on the hot side of the thermoelectric module shall be removed, but any fuses within the thermoelectric circuit may remain. Each ungrounded conductor in the supply circuit shall be provided with a fuse of the maximum rating intended to be used in the branch circuit supply. For cord connected water coolers, the fuses shall correspond in size to the rating of the attachment plug, except that 20 amperes is the minimum size for water coolers rated 120 volts or less. The water cooler shall be operated for not less than 7 hours or until fuses open or burnout of the thermoelectric module occurs. The water cooler shall comply with 75.2.1.1 (a) and (b).

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75.2.3 Thermoelectric water coolers with fans

75.2.3.1 This test is applicable to any thermoelectric water cooler that uses a fan, other than a thermally protected motor, to cool the thermoelectric module. The water cooler shall be connected to a supply circuit maintained as indicated in 59.1. The heat sink shall be in place as intended. The heat sink fan motor shall be electrically energized but the fan shall be locked to prevent turning. If multiple fans are provided, only one fan shall be locked. The water cooler shall be operated until temperatures on the fan motor stabilize or burnout of the thermoelectric module occurs. The water cooler shall comply with 75.2.1.2 (a) and (b).

75.2.4 Thermoelectric circuits powered by other than an extra-low-voltage circuit

75.2.4.1 For a thermoelectric water cooler powered by other than an extra-low-voltage circuit, immediately following the test in 75.2.2.1 if no fan is provided or 75.2.3.1 if provided with a fan, the Dielectric Voltage-Withstand Test in Section 63 shall be conducted. The potential shall be applied between the live parts of the thermoelectric module and dead metal parts.

75.2.5 Dielectric-voltage withstand – 5000 volt test

75.2.5.1 This test applies to a thermoelectric water cooler in which the thermoelectric module is powered by other than an extra-low-voltage supply source and the tests specified in 75.2.1.1 and 75.2.1.3 are not conducted.

75.2.5.2 Two sample modules shall be used for this test. One sample of the module shall be conditioned for 40 hours at 73.4 ±3.6°F (23.0 ±2.0°C) and 50 ±5 percent relative humidity. The other sample shall be conditioned for 96 hours while being exposed to moist air having a relative humidity of 90 ±5 percent at a temperature of 95.0 ±3.6°F (35.0 ±2.0°C).

75.2.5.3 Immediately following the conditioning, each thermoelectric module sample, including any sealant at the lead connections, shall be wrapped with aluminum foil and a potential of 5000 volts shall be applied between the high-voltage live parts of the module and the foil. No dielectric breakdown shall occur.

75.3 Other components

75.3.1 A water cooler shall not result in a risk of fire or electric shock when operated under the conditions as described in 75.3.2 – 75.3.6.

75.3.2 To determine if a risk of fire or electric shock exists, a burnout test shall be conducted on components such as an intermittent-duty relay, solenoid, electrically-operated valve or others which the design of the water cooler indicates may present a risk of fire or electric shock. The tests shall be made with the component installed as intended in the water cooler. The water cooler shall be connected to a supply circuit maintained as indicated in 59.1. Each ungrounded conductor in the supply circuit shall be provided with a fuse of the maximum rating which may be used. For cord connected water coolers, the supply circuit fuses shall correspond in size to the rating of the attachment plug, except that 20 amperes is the minimum size for water coolers rated 150 volts or less.

75.3.3 A risk of fire is considered to exist if there is any emission of flame or molten metal from the water cooler or glowing or flaming of flammable material. Opening of the supply circuit fuse is not considered to be a failure if a risk of fire does not exist.

75.3.4 A risk of electric shock is considered to exist if the insulation resistance of the water cooler is less than 50,000 ohms.

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75.3.5 If a single component failure may result in an intermittent-duty relay or solenoid being continuously energized, a risk of fire or electric shock shall not result from such failure. The test shall be conducted with the relay or solenoid continuously energized until the ultimate result is determined.

75.3.6 If a relay, solenoid, or electrically operated valve becomes blocked in the de-energized position, a risk of fire or electric shock shall not result. The component shall be blocked in the position assumed when it is de-energized and then energized continuously until the ultimate result is determined.

76 Overvoltage and Undervoltage Tests

76.1 An electromagnet, as employed on a relay or solenoid, shall be able to withstand 10 percent above rated voltage without damage to the coil and to operate at 15 percent below rated voltage. The test voltages are to be as indicated in Table 76.1.

Table 76.1
Test voltages

Rated voltage	Overvoltage	Undervoltage
110– 120	132	102
208	229	177
220 – 240	264	204
254 – 277	305	235
440 – 480	528	408
550 – 600	660	510

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76.2 A relay or solenoid that has been separately investigated for the voltage and operating conditions involved, including ambient temperature conditions, is not required to be tested in the water cooler to determine if it complies with the requirement in 76.1.

76.3 If a relay or other control is used in combination with the compressor controller to prevent automatic recycling of the compressor due to the operation of a protective device, the components involved shall comply with 76.1 under any condition which might result from operation of the protective device and de-energizing the circuit.

76.4 Relays and solenoids are to be connected to a supply source maintained at the overvoltage condition until the coils of the relays and solenoids reach constant temperature. The potential is then reduced to the test voltage specified in 59.1, and each relay and solenoid is to operate at this voltage. The potential is maintained at this test voltage until the coils reach constant temperatures. The potential is then reduced to the undervoltage condition, and each relay and solenoid is to operate at this voltage. If relays and solenoids are energized through a transformer, the voltage adjustments described are to be made at the transformer primary. A relay or solenoid which will not be subject to continuous operation is to be energized at the overvoltage condition and at the normal test voltage for the maximum time permitted by its duty cycle or until constant temperature is reached, whichever occurs first.

77 Current Overload Test – Bonding Conductors and Connections

77.1 When required by 17.8 or 17.12, bonding conductors and connections shall carry, without opening, twice the current equal to the rating of the branch circuit overcurrent-protection device for the interval indicated in Table 77.1.

Table 77.1
Current overload test

Rating of overcurrent protection device amperes	Minimum duration of current flow minutes
30 or less	2
31 – 60	4
60 – 100	6

78 Insulation Resistance Test

78.1 Water heaters

78.1.1 An electric heater of the metallic sheath or encased type which is exposed to moisture shall maintain an insulation resistance of not less than 50,000 ohms when cycled in the presence of water and shall not break down in the Dielectric Voltage-Withstand Test, Section 63.

78.1.2 If an encased heater or heater terminal seal is in contact with water as it is used in the water cooler, a test is to be conducted by cycling the heater for 30 days, submerged in water.

78.1.3 In the test the water is to be maintained at a temperature not less than that measured on the heater terminal seal or case material during heater operation, nor more than 194°F (90°C). The heater is to be cycled four times per hour with an ON time of approximately 1-1/2 minutes and an OFF time of approximately 13-1/2 minutes.

78.1.4 If the electric heater is not wetted but is exposed to moisture in the water cooler, a test is to be conducted by cycling the heater assembly or terminal seal in an atmosphere of not less than 98 percent relative humidity.

78.1.5 For the test indicated in 78.1.4, the heater is cycled in a humidity controlled test chamber. The cycle is to be initiated by a time switch and terminated by a control set to disconnect the heater when a temperature rise on the sheath or case is equivalent to the rise measured during the heater operation. The rate of cycling is to be maintained from 3 to 10 cycles per hour for 1000 cycles.

78.2 Thermal and/or acoustical insulating material

78.2.1 A water cooler employing insulating material likely to absorb moisture under conditions of use shall have an insulation resistance of not less than 50,000 ohms between high-voltage live parts and interconnected dead metal parts after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 90 ±4°F (32 ±2°C).

79 Limited Short-Circuit Test

79.1 General

79.1.1 The following components shall withstand short-circuiting when protected by a branch-circuit overcurrent device of the size required for the water cooler:

a) Motor overload protective devices which are connected in the motor circuit.

b) Motor circuit conductors and connections as required by 15.27.

c) Bonding conductors and connections as required by 17.8 and 17.12.

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79.1.2 For a cord-connected unit, the protection specified in 79.1.1 is to be provided by a fuse having a rating not less than the rating of the unit's attachment plug. The minimum fuse size for cord-connected water coolers is to be 20 amperes for units rated 125 volts or less and 15 amperes for units rated 126 – 250 volts.

79.1.3 For a permanently-connected unit, the protection specified in 79.1.1 is to be provided by either:

a) A device that is recognized for branch-circuit protection and located in the unit; or

b) A branch-circuit protective device of the type and maximum rating specified on the product nameplate.

79.1.4 A permanently-connected water cooler having more than one motor wired for connection to one supply line shall withstand short-circuiting when protected by a branch-circuit overcurrent device rated at 225 percent of the rated-load or maximum rated current of the largest hermetic motor of the group plus an amount equal to the sum of any additional loads supplied.If a hermetic motor is not supplied, the branch-circuit overcurrent protective device is to be rated 400 percent of the full-load or maximum operating current of the largest motor of the group plus an amount equal to the sum of any additional loads supplied.

79.1.5 If the permanently-connected water cooler unit incorporates a branch-circuit overcurrent device as described in 79.1.3(a), the test shall be conducted with that device.

79.1.6 With regard to branch-circuit overcurrent protective devices and for the purpose of these tests, fuses and circuit breakers shall not be considered interchangeable.

79.1.7 The component is to be connected in a test circuit having a capacity based on the rated-load current and voltage rating of the water cooler. See Table 79.1. When the rated-load current is between two values in the table, the larger value is to be used in determining the circuit capacity. If the water cooler nameplate shows individual loads, the rated-load current is to be the total of all individual loads that may occur simultaneously. If more than one simultaneous load condition is possible, the condition resulting in the maximum total current is to be used as a basis for determining the capacity of the test circuit. The voltage for the test circuit is to be an alternating current supply, and the circuit capacity is to be measured without the component in the circuit. The power factor of the test circuit is to be 0.9 – 1.0 unless a lower power factor is agreeable to those concerned.

79.1.8 Three samples of each component or conductor under test are to be subjected to each test condition and a new protective device is to be used for each test. Consideration is to be given to both short-circuit and ground-fault conditions.

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Table 79.1
Short-circuit test currents

Full-load amperes[a]				
Single phase				
115 V	208 V	230 – 240 V	277 V	Circuit capacity, amperes
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500

Table 79.1 Continued on Next Page

Table 79.1 Continued

Full-load amperes[a]				
Over 80.0	Over 44.0	Over 40.0	Over 6.65	5000
Three phase				
208 V	**220 – 240 V**	**440 – 480 V**	**550 – 600 V**	**Circuit capacity, amperes**
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.8 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

[a] Water cooler.

79.2 Motor overload protective devices

79.2.1 There shall be no ignition of cheesecloth surrounding the enclosure of a motor protective device when samples are subjected to the test.

79.2.2 If a thermally protected motor or a separately enclosed motor overload protective device is within an outer cabinet, and if the assembly is constructed so that flame and molten metal will be confined within the cabinet and there is no flammable material except electrical insulation with the cabinet, the short-circuit test may be waived.

79.3 Bonding conductors and connections

79.3.1 Bonding conductors and connections shall not open when samples are subjected to this test.

79.4 Motor circuit conductors and connections

79.4.1 Motor circuit conductors and connections shall not be damaged when samples are subjected to this test.

79A Switch Mode Power Supply Units – Overload Test

79A.1 The test applies to switch mode power supply units as specified in 39.1(c).

79A.2 Each output winding, or section of a tapped winding, is overloaded in turn, one at a time, while the other windings are kept loaded or unloaded, whichever load conditions of normal use is the least favorable.

79A.3 Overloading is carried out by connecting a variable resistor (or an electronic load) across the power supply output. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 minute to maintain the applicable overload. No further readjustments are then permitted.

79A.4 For this test, any protective devices such as a fuse, manual reset circuit protector, thermal protector, etc. are allowed to remain in the circuit.

79A.5 If overcurrent protection is provided by an overcurrent protection device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 hr. If this value cannot be derived from the specification, it is to be established by test.

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79A.6 If no overcurrent protection is provided, the maximum overload is the maximum power output obtainable from the power supply.

79A.7 In case of voltage foldback, the overload is to be slowly increased to the point which causes the output voltage to collapse. The overload is then established at the point where the output voltage recovered and held for the duration of the test.

79A.8 The duration of the test is to be for 7 hours or until ultimate results are reached. At the conclusion of the test, there shall be no charring or burning of electrical insulation, no opening of any protective device or any circuit component.

80 Protective Devices – Maximum Continuous Current Test

80.1 To determine if a thermal protector or a protective system complies with the requirement in 24.3.2(a), the water cooler is to be tested in accordance with 80.2, unless the motor-compressor has been separately tested as described in 80.4.

80.2 Except as indicated in 80.3, the water cooler is to be connected to a circuit of rated voltage and operated under the conditions described in Table 80.1 for at least 1 hour or until stable conditions have been reached, whichever is longer. The voltage applied to the water cooler is then to be reduced to 90 percent of its rated voltage (if it will operate at that voltage) and operated until stable conditions exist. The voltage applied to the water cooler is then to be reduced in steps of 2 percent of rated voltage (to the nearest integral volt). Operation is to be allowed to become stable after each reduction in voltage before the next reduction is made, and readings of current input to the motor-compressor are to be noted after stable operation is obtained subsequent to each voltage reduction. This procedure is to be continued until the protective device opens the circuit. If the motor-compressor protective device trips at 90 percent of rated voltage, the voltage applied to the water cooler is to be increased to the rated voltage and the unit operated until stable operation is obtained. The voltage is then to be reduced in the 2 percent steps described above until the protective device opens. The motor-compressor current input at the lowest voltage step during which continuous operation occurs (the lowest voltage preceding the voltage at which the protective device opens the circuit) is to be used as a basis for judging compliance with the requirements in 24.3.2(a).

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Table 80.1
Test conditions for calibration of thermal protectors and protective systems in water coolers

Location	(°F)	(°C)
Air temperature surrounding unit[a]	104	(40)
For bottle type air-cooled unit:		
Air temperature entering condenser	104	(40)
Drinking water temperature entering unit	104	(40)
Drinking water flow rate (minimum)	1 gph (3.8 liters/hour)	
For pressure type air-cooled unit:		
Air temperature entering condenser	104	(40)
Drinking water temperature entering unit	80	(26.7)
Drinking water temperature leaving unit	60	(15.6)
For pressure type water-cooled unit:		
Condenser water temperature entering unit	80	(26.7)

Table 80.1 Continued on Next Page

Table 80.1 Continued

Location	(°F)	(°C)
Condenser water temperature leaving unit	100	(37.8)[b]
Drinking water temperature entering unit	80	(26.7)
Drinking water temperature leaving unit	60	(15.6)

[a] For convenience and if agreeable to all concerned, the test ambient air temperature for water-cooled units may be 77°F (25°C) to permit testing under the same conditions as the Temperature and Pressure Test, Section 62.

[b] Where this condition cannot be attained due to design, the unit is to be tested at 80°F (26.7°C) inlet condenser water temperature and 35 psig nominal pressure.

80.3 With reference to 80.2, initial operation may be at such voltage that the current input is 156 percent of the rated current. The voltage is then to be reduced by 2 percent of rated voltage (to the nearest integral volt) to establish that the protective device opens at 156 percent of rated current or less. The voltage may be reduced to the motor-compressor only, with the other components in the water cooler maintained at rated voltage or higher if the results of the test under these conditions indicate compliance with 24.3.2(a). The rated voltage referred to is the highest of the rated voltages for dual-voltage-rated units. Stable operation is considered to be obtained when two consecutive readings, 15 minutes apart, of the temperature on top of the motor-compressor shell do not change more than 1°F (0.6°C).

80.4 The motor-compressor, with its protective system as employed in the water cooler, may be separately tested as described in 80.2 and 80.3 under the conditions described in Table 80.2. This separate test may be used as a basis for judging compliance with the requirements in 24.3.2(a).

Table 80.2
Test condition for calibration of thermal protectors and protective systems separately from water coolers

Location	°F	(°C)
Return gas:		
Saturated vapor temperature	53.5	(12)
Superheat	26.5	(14.7)
Discharge gas:		
Saturated vapor temperature	154	(68)
Ambient air:		
Temperature	115	(46.5)
Velocity	400 fpm[a]	(2.0 m/s)

[a] The velocity specified is the horizontal air velocity in the test chamber without the compressor installed. The actual velocity across the compressor may be different from this value, depending on the shape of the compressor and its effect on the air-flow pattern. A higher velocity may be employed if the results of the test with the higher air velocity indicate compliance with 24.3.2(a).

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81 Strength Tests – Pressure Containing Components

81.1 General

81.1.1 Pressure containing components shall be capable of withstanding the required test strength pressure without bursting or leakage as specified in these requirements.

81.1.2 Except as specified in 52.4 and 52.5, the requirements in 81.1, 81.2 and 81.4 shall be applied to water coolers in which the marked high-side design pressure equals or exceeds the critical pressure of the refrigerant.

81.1.3 Two samples of each pressure-containing part are to be tested to determine compliance with these requirements. The test samples are to be filled with water or other inert fluid to exclude air and are to be connected in a hydraulic pump system. The pressure is to be raised gradually until the required pressure is reached. This pressure is to be maintained for 1 minute, during which time the samples are not to burst or leak.

81.2 High-side parts

81.2.1 Parts exposed to high-side refrigerant pressure shall be subjected to the higher of the pressures as indicated below:

a) Five times the maximum pressure measured in the Temperature and Pressure Test, Section 62;

b) Five times the minimum design pressure marked on the water cooler nameplate;

c) For water coolers equipped with a pressure relief valve, five times the start-to-discharge pressure of the relief valve;

d) For water coolers equipped with a rupture member, five times the set pressure of the rupture member;

e) For a water-cooled water cooler, five times the high-side pressure measured in the Condenser Water Failure Test, Section 65;

f) For water coolers equipped with a high-side pressure-limiting device, three times the maximum cutout pressure that can be permitted by adjustment of the pressure-limiting device;

g) For an air-cooled water cooler, three times the high-side pressure measured in the Condenser Fan Motor Failure Test, Section 64; or

h) For water coolers equipped with a fusible plug, 2-1/2 times the vapor pressure of the refrigerant used at the relief temperature of the fusible plug or at the critical temperature of the refrigerant used, whichever is the smaller.

81.3 Low-side parts

81.3.1 Except as indicated in 81.3.2, parts exposed to low-side refrigerant pressure shall be subjected to the higher of the pressures as indicated below:

a) Five times the vapor pressure of the refrigerant at 70°F (21.1°C);

b) Three times the maximum low-side pressure measured in the Condenser Fan Motor Failure Test, Section 64 or the Condenser Water Failure Test, Section 65; or

c) Three times the maximum pressure measured in the Temperature and Pressure Test, Section 62.

81.3.2 Low-side pressure vessels shall be subjected to a pressure equal to five times the start-to-discharge pressure of the pressure vessel relief valve.

81.4 Leakage at gaskets or seals

81.4.1 Leakage at gaskets or seals shall not occur at a pressure less than 40 percent of the required strength test pressure.

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81.4.2 A component shall be capable of withstanding the required strength test pressure even though leakage occurs at the gaskets or seals.

81.5 Water-heating tanks

81.5.1 An unvented water-heating tank shall be tested as indicated in 81.1.3 except that:

a) The time for maintaining the test pressure shall be as specified in 81.5.2 – 81.5.3; and

b) Only one sample is required to be tested.

81.5.2 The test pressure of 300 psig (2.07 MPa) shall be maintained in the tank for not less than 15 minutes.

81.5.3 In reference to 81.5.2 and for a tank that does not exceed 2-1/2 gallons (9.5 liters) in capacity, the test duration may be reduced to 1 minute if the pressure is increased to 500 psig (3.45 MPa).

81.6 Pressurized beverage product system

81.6.1 Parts of a product system pressurized by compressed gas or a pump, including carbonation systems, shall withstand a pressure equal to the higher of:

a) Five times the start-to-discharge pressure of the relief valve; or

b) Five times the maximum pressure that the pump can develop, if parts are pressurized by a pump; or

c) Not less than 650 psig (4.5 MPa).

81.6.2 The pressurized parts, which may include pump housings, containers, interconnecting lines, and fittings that form part of a pressurized system, shall be tested as described in 81.1.3. Except as indicated in 81.6.3, leakage shall not occur.

81.6.3 In reference to 81.6.2, if leakage occurs, it shall only occur at valves, tubing, and connections. Tests on three samples of each leaking part shall demonstrate that:

a) Leakage occurs at a pressure greater than 40 percent of the pressure required 81.6.1 and

b) Liquid from such leakage does not impinge on uninsulated live parts.

81.7 Water-containing parts for pressure-type water coolers

81.7.1 Parts of a pressure type water cooler that are exposed to water pressure shall be subjected to the higher of either 150 psig (1035 kPa) or two times the maximum water supply line pressure as specified in the installation and/or operating instructions in accordance with 6.1(d).

82 Start-To-Discharge Test

82.1 A pressure-relief device not complying with 54.3 but used in a pressurized beverage product system, shall relieve at a pressure not exceeding its rated start-to-discharge pressure.

82.2 Three samples of the pressure-relief device are to be tested. Each sample is to be connected to a gas source, such as air, carbon dioxide, or nitrogen, but oxygen or any flammable gas is not to be used. The sample is to be immersed in water, and the pressure is to be gradually increased until the device

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starts to discharge as evidenced by the occurrence of bubbles in the water. The highest value obtained in tests of the three samples is to be used to determine compliance with 82.1.

83 Protective Electronic Circuit Tests

83.1 General

83.1.1 The tests in 83.2 – 83.5 are applicable to appliances provided with a protective electronic circuit and intended to comply with 21.13(g) or 24.5.1(c).

83.1.2 User adjustable controls shall be adjusted to their most unfavorable setting.

83.2 Fault conditions abnormal test

83.2.1 Following the application of the operational fault conditions in accordance with 83.2.2 – 83.2.5, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage Withstand Test in Section 63.

83.2.2 In accordance with 21.32(b), an appliance provided with a protective electronic circuit intended to comply with 21.13(g) or 24.5.1(c) shall be operated as specified in the Temperature and Pressure Test, Section 62 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F). The appliance protective electronic circuit shall then be subjected to any one of the following relevant operational fault conditions, each consecutively applied one at a time:

a) Open circuit at the terminals of any component;

b) Short circuit of capacitors, unless they comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14;

c) Short circuit of any two terminals of an electronic component, including a metal oxide varistor (MOV). For the test applicable to an integrated circuit, see item (e);

d) Failure of triacs in the diode mode;

e) Failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals occurring within the component which may result in the appliance not complying with 83.2.1 shall be considered;

f) Failure of an electronic power switching device, such as a field effect transistor and a bipolar transistor (including the insulated gate type) in a partial turn-on mode with loss of gate (base) control; and

g) Short-circuiting of any circuit that differs in voltage from the supply source of the protective electronic circuit by connecting the different voltage circuit to the supply source.

83.2.3 In reference to 83.2.2, the following items shall be considered:

a) If the fault specified in 83.2.2(c) is not applied:

1) Between two circuits of an optical isolator, then the optical isolator shall comply with the Standard for Optical Isolators, UL 1577.

2) To the short circuiting of an electronic surge protective device such as a metal oxide varistor (MOV), then the MOV shall comply with the Type 4 requirements in the Standard for Surge Protective Devices, UL 1449.

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b) For evaluating encapsulated or similar components, if the circuit and/or components cannot be evaluated by other methods, then 83.2.2(e) shall be applied.

c) For evaluating the components in 83.2.2(f), one method for simulating this mode is to disconnect the electronic power switching device gate (base) terminal and then connect an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply can then be varied to obtain the current which is the most severe but which does not damage the electronic power switching device.

d) Step-function positive temperature coefficient thermistors (PTC-S) shall be short-circuited unless they comply with the DC PTC Thermistors requirements in 14.6.4 of the Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements, UL 60065.

e) If more than one of the operational fault conditions in 83.2.2 (a) – (g) are applicable to the appliance, the appliance shall be allowed to cool down to room temperature after the application of each fault condition unless such cooling is determined not to adversely impact the test results.

83.2.4 The operational fault conditions specified in 83.2.2(a) – (g) shall be considered completed if a manual reset (non-self-resetting) device opens the supply circuit. If the supply circuit is not opened by such a device, then the fault conditions shall be applied until thermal equilibrium is established.

83.2.5 An appliance provided with a protective electronic circuit intended to comply with 21.13(g) or 24.5.1(c) shall additionally be operated as specified 83.2.2 except that the appliance shall first be subjected to the relevant abnormal condition(s) addressed by Sections 9.3, 9.4, 12.2.1, 24.2 – 24.5, 53, 64, 65, 71, 75 and 87. The appliance protective electronic circuit shall then be subjected to any one of the relevant operational fault conditions as outlined in 83.2.2(a) – (g), each consecutively applied one at a time.

83.3 Electromagnetic compatibility (EMC) tests

83.3.1 In accordance with 21.32(e), an appliance having a protective electronic circuit intended to comply with 21.13(g) or 24.5.1(c) shall be subjected to the electromagnetic phenomena specified in 83.3.3 – 83.3.9, each applied one at a time. Each test shall be carried out:

a) After a protective electronic circuit has operated during the relevant abnormal condition(s) addressed by Sections 9.3, 9.4, 12.2.1, 24.2 – 24.5, 53, 64, 65, 71, 75 and 87 taking into account the most severe results (e.g., highest temperatures, pressures, etc.);

b) At conditions specified in the Temperature and Pressure Test, Section 62 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F) unless different conditions are required by the specific abnormal condition being applied; and

c) With surge protective devices disconnected unless they incorporate spark gaps.

83.3.2 Following the application of each electromagnetic stress, a protective electronic circuit shall continue to operate as intended. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage-Withstand Test in Section 63.

83.3.3 Electrostatic discharges shall be applied in accordance with IEC 61000-4-2, the Standard for Electromagnetic compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity shall be applied at each preselected point.

83.3.4 Radiated fields shall be applied in accordance with IEC 61000-4-3, the Standard for Electromagnetic compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-

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Frequency, Electromagnetic Field Immunity Test. The frequency ranges tested shall be 80 MHz to 1000 MHz, test level 3; 1.4 GHz to 2.0 GHz, test level 3; and 2.0 GHz to 2.7 GHz, test level 2. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

83.3.5 Fast transient bursts shall be applied in accordance with IEC 61000-4-4, the Standard for Electromagnetic compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 minutes with a positive polarity and for 2 minutes with a negative polarity.

83.3.6 Voltage surges shall be applied to the appliance power supply terminals in accordance with IEC 61000-4-5, the Standard for Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test with five positive impulses and five negative impulses being applied at the selected points. An open circuit test voltage of 2 kV is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 ohms being used. An open circuit test voltage of 4 kV is applicable for the line-to-ground coupling mode, a generator having a source impedance of 12 ohms being used. Sheathed heating elements in which a metal sheath is bonded in accordance with 17.1 shall be electrically disconnected during this test. For appliances having surge arresters incorporating spark gaps, the test shall be repeated at a level that is 95 percent of the flashover voltage. If a feedback system depends on inputs related to a disconnected heating element, an artificial network may be needed.

83.3.7 Injected currents shall be applied in accordance with IEC 61000-4-6, the Standard for Electromagnetic compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields, test level 3 being applicable. During the test, all frequencies between 0.15 MHz to 80 MHz shall be covered. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

83.3.8 Voltage dips and interruptions specified as test level Class 3 shall be applied in accordance with:

a) IEC 61000-4-11, the Standard for Electromagnetic compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests, for appliances having a rated current not exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-11 shall be applied at zero crossing of the supply voltage; or

b) IEC 61000-4-34, the Standard for Electromagnetic compatibility (EMC) – Part 4-34: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current More Than 16 A Per Phase for appliances having a rated current exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-34 shall be applied at zero crossing of the supply voltage.

83.3.9 Supply source (mains) signals shall be tested in accordance with IEC 61000-4-13, the Standard for Electromagnetic compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at a.c. Power Port, Low Frequency Immunity Tests. Table 11 with test level Class 2 using the frequency steps according to Table 10 of IEC 61000-4-13 shall be applied.

83.4 Programmable component reduced supply voltage test

83.4.1 In accordance with 21.32(f), the following test is applicable to an appliance provided with a protective electronic circuit intended to comply with 21.13(g) or 24.5.1(c) and having a programmable component for one or more of its safety functions

83.4.2 Following the voltage changes specified in 83.4.3, an appliance shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart the appliance. In addition, there shall be no risk of fire, electric shock

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or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage-Withstand Test in Section 63.

83.4.3 The appliance shall be operated at rated voltage and at conditions specified in the Temperature and Pressure Test, Section 62 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F) until thermal equilibrium occurs. The power supply voltage shall then be changed, by approximately 10 V/s until the voltage reductions or increases specified in (a) – (d) are attained. The power supply voltage shall then be maintained at each voltage condition for not less than 60 seconds as follows:

a) Voltage shall be reduced until the appliance ceases to respond to user inputs or parts controlled by the programmable component cease to operate, whichever occurs first. This value of supply voltage shall be recorded;

b) Voltage shall be increased to rated voltage so that the appliance operates as intended;

c) Voltage shall be reduced to a value that is approximately 10 percent less than the recorded voltage; and

d) Voltage shall be increased so that the appliance operates as intended.

83.5 Fuse-link test

83.5.1 In accordance with 21.32(c), the following test is applicable to an appliance provided with a protective electronic circuit intended to comply with 21.13(g) or 24.5.1(c) and in which a miniature fuse-link opens during the application of one or more of the operational fault conditions specified in 83.2.

83.5.2 The fault condition in which the miniature fuse-link opened shall be repeated in accordance with the relevant parts of 83.2 except with the fuse replaced by an ammeter. The current in the circuit shall be measured.

83.5.3 The resistance of the fuse-link shall be measured so that the rated current through the fuse can be determined. The current measured by the ammeter described by 83.5.2 is to be multiplied by the ammeter internal resistance and then divided by the resistance of the fuse link to obtain the rated current of the fuse-link for making the determinations specified in 83.5.4.

83.5.4 If the calculation determined in accordance with 83.5.3:

a) Is at least 2.75 times the rated current of the fuse-link, the circuit is considered to be protected and the results obtained during the tests of 83.2 with the fuse-link in the circuit can be used to determine compliance with 83.2.1;

b) Is between 2.1 times and 2.75 times the rated current of the fuse-link, the relevant fault condition(s) in accordance with 83.2 shall be repeated with the fuse-link short-circuited. The test shall be conducted until the lesser of one of the following occurs and the results shall comply with 83.2.1:

1) 2 minutes for time lag fuse-links; or

2) 30 minutes for quick acting fuse-links; or

3) until thermal equilibrium is achieved.

c) Is 2.1 times the rated current of the fuse-link or less, the circuit shall not be considered to be protected and the relevant fault condition(s) in accordance with 83.2 shall be repeated with the fuse-link short-circuited. The results shall comply with 83.2.1.

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84 Accelerated Aging Test – Electric Heaters

84.1 The following requirement applies to the cases of heater assemblies and terminal seals of metallic sheath heaters.

84.2 Rubber, neoprene, or thermoplastic compounds used as a heater casing or for the seal of terminals shall withstand accelerated aging as indicated in Table 84.1 for the maximum temperature rise measured on the device during a temperature test conducted in an ambient from 77 to 104°F (25 to 40°C) without deteriorating to a degree which will affect its use.

Table 84.1
Accelerated aging test criteria

Measured temperature rise		Material	Test program
°C	(°F)		
35	(63)	Rubber or neoprene	70-hour air oven aging test at 100°C ±2°C (212°F ±3.6°F)
35	(63)	Thermoplastic	7 days in an air-circulating oven at 100°C (212°F)
50	(90)	Rubber or neoprene	168-hour air oven aging test at 100°C ±2°C (212°F ±3.6°F)
50	(90)	Thermoplastic	10 days in an air-circulating oven at 100°C (212°F)
55	(99)	Rubber, neoprene, or thermoplastic	7 days in an air-circulating oven at 113°C (235.4°F)
65	(117)	Rubber or neoprene	10 days in an air-circulating oven at 121°C (249.8°F)
65	(117)	Thermoplastic	7 days at 121°C (249.8°F) or 60 days at 97°C (206°F) in an air-circulating oven
80	(144)	Rubber, neoprene, or thermoplastic	7 days in an air-circulating oven at 136°C (276.8°F)
100	(180)	Rubber, neoprene, or thermoplastic	60 days in an air-circulating oven at 136°C (276.8°F)
125	(225)	Rubber, neoprene, or thermoplastic	60 days in an air-circulating oven at 158°C (316.4°F)
175	(315)	Rubber, neoprene, or thermoplastic	60 days in an air-circulating oven at 210°C (410°F)

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85 Reliability Test – Heater Terminations

85.1 Electric heaters employing integrally molded leads or molded terminal assemblies shall withstand a test load of 20 pounds-force (89.0 N) applied for 1 minute. The load is to be applied in the same direction at which the lead exits the heater case or molded connection and is not to result in displacement of insulation or separation of the connection between the lead and heater.

86 Accelerated Aging Tests on Gaskets, Sealing Compounds, and Adhesives

86.1 86.2 – 86.6 apply to gaskets and sealing compounds required for electrical enclosures as determined during the Rain Test, Section 68. 86.7 applies to adhesives required to secure such gaskets to enclosures or covers.

86.2 Neoprene or rubber compounds, except foamed materials, shall have physical properties as indicated in Table 86.1 before and after accelerated aging under the conditions indicated in Table 86.2.

Table 86.1
Physical properties for gaskets

	Neoprene or rubber compound		Polyvinyl-chloride materials	
	Before test	After test	Before test	After test
Recovery – maximum set when 1-inch (25.4-mm) gage marks are stretched to 2-1/2 inches (63.5 mm), held for 2 minutes and measured 2 minutes after release	1/4 inch (6.4 mm)	–	Not specified	
Elongation – Minimum increase in distance between 1-inch (25.4 mm) gage marks at break	250 percent (1 to 3-1/2 inches) (25.4 to 88.9 mm)	65 percent of original	250 percent (1 to 3-1/2 inches) (25.4 to 88.9 mm)	75 percent of original
Tensile strength – Minimum force at breaking point	850 psi (5.86 MPa)	75 percent of original	1200 psi (8.27 MPa)	90 percent of original

Table 86.2
Accelerated aging conditions

Measured temperature rise		Material	Test program
°C	(°F)		
35	(63)	Rubber or neoprene	70-hour air oven aging test at 100°C ±2°C (212°F ±3.6°F)
35	(63)	Thermoplastic	7 days in an air-circulating oven at 87°C (189°F)
50	(90)	Rubber or neoprene	168-hour air oven aging test at 100°C ±2°C (212°F ±3.6°F)
50	(90)	Thermoplastic	10 days in an air-circulating oven at 100°C (212°F)
55	(99)	Rubber, neoprene, or thermoplastic	7 days in an air-circulating oven at 113°C (235.4°F)
65	(117)	Rubber or neoprene	10 days in an air-circulating oven at 121°C (249.8°F)
65	(117)	Thermoplastic	7 days at 121°C (249.8°F) or 60 days at 97°C (206°F) in an air-circulating oven
80	(144)	Rubber, neoprene, or thermoplastic	7 days in an air-circulating oven at 136°C (276.8°F)

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86.3 Foamed neoprene or rubber compounds are to be subjected to accelerated aging under the conditions indicated in Table 86.2. The compounds shall not harden or otherwise deteriorate to a degree which will affect their sealing properties.

86.4 Thermoplastic materials shall be subjected to accelerated aging under the conditions indicated in Table 86.2. Thermoplastic material shall not deform or melt, or otherwise deteriorate to a degree which will affect its sealing properties. Solid polyvinyl-chloride gasket material shall have physical properties as indicated in Table 86.1 before and after the accelerated aging.

86.5 Gaskets of materials other than those mentioned in 86.2 – 86.4 shall be nonabsorptive and shall provide equivalent resistance to aging and temperatures.

86.6 Sealing compounds shall be applied to the surface they are intended to seal. A representative sample of the surface with the sealing compound applied shall be subjected to accelerated aging under the conditions indicated in Table 86.2 for air-circulated oven exposure. The sealing compound shall not melt, become brittle, or otherwise deteriorate to a degree which will affect its sealing properties as determined by comparing the aged sample to an unaged sample.

86.7 Where gaskets are secured by adhesives, samples of the gasket adhesive and mounting surface shall be subjected to:

a) Accelerated aging under the conditions indicated in Table 86.2 for air-circulated oven exposure and

b) Immersion in distilled water for 3 days.

The force required to peel the gasket from its mounting surface after exposure shall be not less than 50 percent of the value determined on "as-received" samples and in no case less than 2 pounds per inch (0.35 N/mm) of gasket width.

86.8 The temperatures indicated in Table 86.2 correspond to the maximum temperature rise measured on the gasket during the Temperature and Pressure Test, Section 62.

87 Ultraviolet Irradiance Test

87.1 This test applies to any water cooler having a UV radiation system.

87.2 Doors or covers that may be opened or removed without the use of tools or not protected with an interlocking mechanism shall be removed, opened or adjusted in a position that permits the exposure of the maximum amount of UV radiation.

87.3 The test shall be performed with a UV lamp that has not been previously used.

87.4 The water cooler shall be installed within a closed room that will not permit any external source of UV radiation. The ambient temperature shall be maintained at 77 ±3°F (25 ±2°C) with a relative humidity of 50 ±5 percent.

87.5 The amount of UV emissions shall be measured at any points around the outside of the water cooler cabinet and within areas inside the cabinet that are accessible without the use of tools or not protected with an interlocking mechanism as specified in 87.2. This includes measuring any UV radiation that may be emitted from the water inlet or outlet connections. Measurements shall be taken at a distance of 0 inches (0 mm) away from any accessible part or opening.

87.6 The emissions shall be measured with equipment capable of measuring UV radiation in the wavelength range of 200 – 400 nm. Use of a double monochromator is recommended for ensuring the needed accuracy in measuring the UV emissions in accordance with Annex B, Clause B.1.1 in the Standard for Photobiological Safety of Lamps and Lamp Systems, IEC 62471.

87.7 The effective irradiance shall then be determined based on the spectral weighted values as a function of the UV wavelength in accordance with Clause 4.3.1 in IEC 62471.

87.8 At the conclusion of the test, the emissions of UV radiation shall not exceed an 8 hour level of effective irradiance of 0.1 $\mu W/cm^2$ in accordance with 43.2.

88 Metallic Coating Thickness Test

88.1 The solution to be used for the Chromic Acid Dropping Test is to be made from distilled water and is to contain 200 grams per liter of chemically pure chromic acid, CrO_3, and 50 grams per liter of chemically pure concentrated sulfuric acid, H_2SO_4. The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

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88.2 The test solution is to be contained in a glass vessel, such as a separatory funnel, with the outlet equipped with a stopcock and a capillary tube of approximately 0.025 inches (0.64 mm) inside bore and 5.5 inches (140 mm) long. The lower end of the capillary tube is to be tapered to form a tip; the drops from which are to be approximately 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

88.3 The sample and the test solution should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature of 70 to 90°F (21.1 to 32.2°C).

88.4 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of suitable solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care should be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

88.5 The sample to be tested is to be supported 0.7 – 1 inch (17.8 – 25.4 mm) below the orifice so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested should be inclined approximately 45 degrees from horizontal.

88.6 After cleaning, the sample to be tested is to be placed under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stopwatch until the dropping solution dissolves off the protective metallic coating exposing the base metal. The end point is the first appearance of the base metal recognizable by the change in color at that point.

88.7 Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface, and at an equal number of points on the outside surface, at places where the metallic coating may be expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

88.8 To calculate the thickness of the coating being tested, select from Table 88.1 the thickness factor appropriate for the temperature at which the test was conducted and multiply by the time in seconds required to expose base metal as determined in 88.6.

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Table 88.1
Coating thickness factors

Temperature in degrees,		Thickness factors, 0.00001 inches (0.0003 mm) per second	
°F	(°C)	Cadmium platings	Zinc platings
70	(21.1)	1.331	0.980
71	(21.7)	1.340	0.990
72	(22.2)	1.352	1.000
73	(22.8)	1.362	1.010
74	(23.3)	1.372	1.015
75	(23.9)	1.383	1.025
76	(24.4)	1.395	1.033
77	(25.0)	1.405	1.042

Table 88.1 Continued on Next Page

Table 88.1 Continued

Temperature in degrees,		Thickness factors, 0.00001 inches (0.0003 mm) per second	
°F	(°C)	Cadmium platings	Zinc platings
78	(25.6)	1.416	1.050
79	(26.1)	1.427	1.060
80	(26.7)	1.438	1.070
81	(27.2)	1.450	1.080
82	(27.8)	1.460	1.085
83	(28.3)	1.470	1.095
84	(28.9)	1.480	1.100
85	(29.4)	1.490	1.110
86	(30.0)	1.501	1.120
87	(30.6)	1.513	1.130
88	(31.1)	1.524	1.141
89	(31.7)	1.534	1.150
90	(32.2)	1.546	1.160

89 Marking Label Adhesion Tests

89.1 General

89.1.1 After being subjected to the conditions described in 89.2.1 – 89.5.1, a pressure-sensitive label or a label secured by cement or adhesive is considered to be of a permanent nature if immediately following removal from each test medium:

a) Each sample demonstrates good adhesion and the edges are not curled,

b) The label resists defacement or removal as demonstrated by scraping across the test panel with a flat metal blade 1/32 inch (0.8 mm) thick, held at right angles to the test panel, and

c) The printing is legible and is not defaced by rubbing with thumb or finger pressure.

89.2 Oven-aging test

89.2.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in an air oven maintained at the temperature indicated in Table 89.1 for 240 hours, and then allowed to cool in a controlled atmosphere maintained at 73.4 ±3.2°F (23 ±2°C) and 50 ±5 percent relative humidity.

Table 89.1
Temperatures, oven-aging test

Maximum temperature of surfaces to which applied[a]	Test temperature
60°C (140°F) or less	87°C (189°F)
80°C (161°F) or less	105°C (221°F)
100°C (212°F) or less	121°C (250°F)
125°C (257°F) or less	150°C (302°F)

Table 89.1 Continued on Next Page

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Table 89.1 Continued

Maximum temperature of surfaces to which applied[a]	Test temperature
150°C (302°F) or less	180°C (356°F)
Over 150°C (302°F)	b

[a] As measured during temperature tests.

[b] A label which is applied to a surface attaining a temperature greater than 150°C (302°F) during the temperature tests is to be oven-aged at a temperature which is representative of the temperature attained by the refrigerator during normal and abnormal operation.

89.3 Immersion test

89.3.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 73.4 ±3.2°F (23 ±2°C) and 50 ±5 percent relative humidity for 24 hours. The samples are then immersed in water at a temperature of 69.8 ±3.2°F (21 ±2°C) for a period of 48 hours.

89.4 Standard-atmosphere test

89.4.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 73.4 ±3.2°F (23 ±2°C) and 50 ±5 percent relative humidity for 72 hours.

89.5 Unusual-condition exposure test

89.5.1 If the labels are exposed to unusual conditions in service, such as oil, grease, cleaning solutions, or the like, three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 73.4 ±3.2°F (23 ±2°C) and 50 ±5 percent relative humidity for 24 hours. The samples are then to be immersed for 48 hours in a solution representative of service use maintained at the temperature the solution would attain in service, but in no case less than 73.4 ±3.2°F (23 ±2°C).

90 Refrigerant Identification Tests

90.1 General

90.1.1 These tests are applicable to refrigerants required to be subjected to a compositional analysis in accordance with 49.2(b) and 49.3. The infrared analysis in 90.2 applies to single component (“pure”) refrigerants. The gas chromatography analysis in 90.3 applies to blended (more than one component) refrigerants.

90.2 Infrared analysis

90.2.1 An infrared analysis shall be performed with a Fourier Transform Infrared (FTIR) spectrometer and/or Dispersive Infrared spectrophotometer. The infrared spectra obtained shall consist of a minimum wavenumber range of 4000 – 400 reciprocal centimeters.

90.2.2 A representative sample of a single component refrigerant shall be captured in a sealed cell and the infrared spectra of the refrigerant shall be obtained.

90.2.3 The results shall be recorded as a plot of the percent transmittance of the infrared radiation through the specimen versus the reciprocal wavelength (cm-1) or “wavenumber” of the radiation. Percent transmittance shall be expressed on the ordinate and wavenumber on the abscissa.

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