UL 174

STANDARD FOR SAFETY

Household Electric Storage Tank Water Heaters

UL Standard for Safety for Household Electric Storage Tank Water Heaters, UL 174

Eleventh Edition, Dated April 29, 2004

Summary of Topics

This revision of ANSI/UL 174 dated December 16, 2021 includes a clarification of requirement for nonmetallic dip tubes; 17.2.3

Text that has been changed in any manner or impacted by UL'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 October 22, 2021.

No Text on This Page

APRIL 29, 2004
(Title Page Reprinted: December 16, 2021)

ANSI/UL 174-2021

UL 174

Standard for Household Electric Storage Tank Water Heaters

First Edition – November, 1948
Second Edition – June, 1956
Third Edition – May, 1970
Fourth Edition – June, 1972
Fifth Edition – September, 1977
Sixth Edition – May, 1979
Seventh Edition – April, 1983
Eighth Edition – November, 1989
Ninth Edition – June, 1995
Tenth Edition – February, 1996

Eleventh Edition

April 29, 2004

This ANSI/UL Standard for Safety consists of the Eleventh Edition including revisions through December 16, 2021.

The most recent designation of ANSI/UL 174 as an American National Standard (ANSI) occurred on December 10, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover household electric storage tank and small capacity storage tank water heaters rated no more than 600 volts and 12 kilowatts to be installed in accordance with the National Electrical Code, NFPA 70, and with model plumbing and mechanical codes.

1.2 These requirements do not cover immersed electrode, side arm, booster, instantaneous or immersion type water heaters or water heating portions of water dispensing appliances. These requirements do not cover water heaters with a tank capacity of less than 1 gallon (3.8 L) or more than 120 gallons (454 L).

1.3 Electric booster water heaters, electric commercial storage tank water heaters, and remote control assemblies for such heaters, rated 600 volts or less are not covered by this standard. They are covered in the Standard for Electric Booster and Commercial Storage Tank Water Heaters, UL 1453.

1.4 Permanently installed electric water heaters, rated 600 volts or less, for heating the water supplied through plumbing to separately heated public or private pools or tubs, in which swimming, wading, bathing, or partial or total immersion of persons, is to be involved are not covered by this standard. They are covered in the Standard for Electric Water Heaters for Pools and Tubs, UL 1261.

1.5 Water heaters rated 600 volts or less with a tank capacity of less than 1 gallon (3.8 liters) are not covered by this standard. They are covered under the Standard for Electric Heating Appliances, UL 499.

1.6 A water heater intended for use in a hazardous location is to be judged on the basis of its compliance with these requirements; however, further examination and testing shall be conducted to determine whether it is acceptable for the intended use.

2 Components

2.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the individual sections of this standard for component requirements.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3.2 Unless otherwise stated, all electrical measurements are in root-mean-square units (rms).

4 Undated References

4.1 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.

5 Glossary

5.1 For the purposes of these requirements, the following definitions shall apply.

5.2 DIP TUBE – A metallic or other tube attached to the inlet of a storage tank for the purpose of carrying cold inlet water to the bottom of the tank.

5.3 ENCLOSURE – The part of an electric water heater that surrounds insulated and uninsulated current-carrying live parts and that is intended to contain a fire resulting from an electrical fault.

5.3.1 FRAME – A structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected.

5.4 HEAT TRAP – A device that is capable of being integrally assembled or independently attached to the hot water connection of a water heater such that a portion of this device develops a cold water seal to reduce the natural convection and resultant heat loss from the hot water stored in the water heater.

5.5 INLET WATER DEFLECTOR (DIFFUSER) – A component, usually nonmetallic, attached to the inlet tube or pipe when the inlet is at or near the bottom of the water heater tank, that serves to spread the cold water uniformly on a horizontal plane to aid in mixing of the hot and cold water.

5.5.1 OPERATING CONTROL – A control intended to start or regulate the appliance during normal operation. An example would be a water temperature-regulating control. An operating control could provide Type 1 or Type 2 action. (See definitions 5.9 and 5.10.)

5.6 OUTER JACKET – The part of the water heater that surrounds the storage tank and that is intended to provide mechanical protection for the tank and for thermal insulation when the insulation is provided. The outer jacket also serves as an enclosure of current-carrying parts and insulated conductors between heating elements in separate control or wiring compartments.

5.6.1 PROTECTIVE CONTROL – A control intended to prevent the risk of electric shock, fire, or injury to persons during abnormal operation of the appliance. An example would be a water temperature limit control. A protective control always provides Type 2 action. (See definitions 5.9 and 5.10.)

5.7 SMALL CAPACITY STORAGE TANK WATER HEATER – A water heater marked with a rated capacity within the range of 1 gallon (3.8 L) to 5 gallons (18.9 L).

5.8 STORAGE TANK – The part of the heater (either with or without the heating elements) that is intended to contain or store water and that has a rated capacity of 1 gallon (3.8 L) or more.

5.8.1 THERMOSTATIC MIXING VALVE – A device installed on the water heater that automatically moderates the water outlet temperature independent of the water heater temperature-regulating control setting.

5.9 TYPE 1 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have not been declared and tested to the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

5.10 TYPE 2 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested to the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

CONSTRUCTION

6 Frame, Enclosures, and Outer Jacket

6.1 General

6.1.1 The frame, if provided, enclosure, and outer jacket of a water heater shall have the strength and rigidity required to resist the abuses encountered during intended use. The degree of resistance inherent in the appliance shall preclude total or partial collapse, with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects that alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

6.2 Enclosures

6.2.1 A sheet-metal enclosure made of steel or aluminum that encloses or protects a live electrical part shall have a minimum thickness as indicated in Table 6.1. A cast-metal enclosure shall have a minimum thickness as indicated in Table 6.2.

Exception: An enclosure thinner than specified in Table 6.1 and Table 6.2 is able to be used when it complies with Section 41, Enclosure Strength Test.

Table 6.1
Minimum thickness of sheet-metal enclosures

	Sheet steel					
	Uncoated		Galvanized		Sheet aluminum	
	inch	(mm)	inch	(mm)	inch	(mm)
Sheet metal enclosing live parts in a heater of any size, either (1) not serving as the jacket or (2) serving as the jacket of a heater of no more than 52 gallons (197 L) capacity.	0.020	(0.51)	0.023	(0.58)	0.032	(0.81)
Sheet metal enclosing live parts and serving as the outer jacket of a heater of more than 52 gallons capacity.	0.026	(0.66)	0.029	(0.74)	0.036	(0.91)

Table 6.2
Minimum thickness of cast metal enclosures

	Cast metal		Malleable iron		Die cast metal	
	inch	(mm)	inch	(mm)	inch	(mm)
Unreinforced blast surfaces of enclosures housing electrical parts	0.125	(3.18)	0.094	(2.39)	0.078	(1.98)
Curved, ribbed, or otherwise reinforced enclosures for electrical parts	0.094	(2.39)	0.062	(1.57)	0.047	(1.19)

6.2.2 A magnesium enclosure shall not be used unless the following are taken into consideration:

a) Mechanical strength;

b) Resistance to impact; and

c) Combustibility under conditions of intended or abnormal use.

6.2.3 An enclosure made of polymeric material shall comply with the fixed equipment requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and be rated for the maximum temperature it is subjected to during normal operation as determined during the Temperature Test specified in Section 28.

Exception: A water heater is required to comply only with the stationary equipment requirements in UL 746C when the water heater has:

a) A tank capacity of five gallons (18.9 L) or less; and

b) A power-supply cord provided in accordance with Electrical Supply Connections – Cord Connection, Section 12.

6.3 Outer jacket

6.3.1 A sheet metal outer jacket of steel or aluminum that also encloses insulated or uninsulated current-carrying parts shall have a minimum thickness as indicated in Table 6.1.

Exception: An outer jacket thinner than specified in Table 6.1 is able to be used when it meets the requirements in Section 41, Enclosure Strength Test.

6.3.2 An outer jacket of polymeric material that also encloses insulated or uninsulated current-carrying parts shall comply with the enclosure requirements in Table 6.3 and Table 6.4.

Exception: An outer jacket is required to comply only with the requirements in Table 6.5, when the outer jacket:

a) Does not enclose any current-carrying parts; or

b) Encloses parts that are completely covered with minimum 1/32 inch (0.8 mm) thick electrical insulation.

Table 6.3
Polymeric material enclosure application code

Supply connection	Encloses current-carrying parts		Direct support of current-carrying parts	Indirect support of current-carrying parts	Enclosure application code
	Parts with insulation less than 0.028 inch (0.71 mm) thick	No parts with insulation less than 0.028 inch (0.71 mm) thick			
Conduit	X	–	–	–	1
Conduit	–	X	–	–	2
Conduit	X	–	X	–	3
Conduit	X	–	–	X	4
Conduit	–	X	–	X	5
Cord	X	–	–	–	6
Cord	–	X	–	–	7
Cord	X	–	X	–	8
Cord	X	–	–	X	9
Cord	–	X	–	X	10

Table 6.4
Polymeric material enclosure property and test requirements

Application code (see Table 6.3 for code)	Minimum flammability classification[a]	Resistance to ignition		Electrical				End product tests[d]			
		Maximum hot wire (HWI)[b] PLC[c]	Maximum high current (HAI)[b] PLC[c]	Minimum dielectric strength, volts[b]	Maximum high voltage track rate (HVTR)[b] PLC[c]	Maximum comparative tracking index (CTI)[b] PLC[c]	Volume resistivity[b] 50 me gohms /cm wet	Input resistance	Crush resistance	Mold stress relief	Strain relief
1	5V	3	2	5000	–	–	X	X	X	–	–
2	5V	–	2	5000	–	–	–	X	–	X	–
3	5V	3	2	5000	1	4	X	X	X	X	–
4	5V	3	2	5000	–	–	X	X	X	–	–
5	5V	–	2	5000	–	–	–	X	–	–	–
6	5V	3	2	5000	–	–	X	X	X	–	X
7	5V	–	2	5000	–	–	–	X	–	X	X
8	5V	3	2	5000	1	4	X	X	X	X	X
9	5V	3	2	5000	–	–	X	X	X	–	X
10	5V	–	2	5000	–	–	–	X	–	–	X

[a] The flammability classification is to be determined by tests described in the Standard for Tests for Flammability of Plastic Material for Parts in Devices and Appliances, UL 94, unless it has already been determined to be 5V.

[b] Tests are to be conducted in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

[c] The Performance Level Category (PLC) value is as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[d] Tests are to be conducted in accordance with UL 746C.

Table 6.5
Polymeric outer jacket

Part	Impact test[a]	Burning characteristics		Moisture resistance[d]
		Maximum flame spread index[b]	Minimum flammability classification[c]	
Outer jacket, indoor only				
A. Less than 10 square feet (0.93 m^2) and all dimension less than 6 feet (1.83 m)	X	–	HB	–
B. 10 square feet or more, or a single dimension greater than 6 feet	X	200	HB	–
Outer Jacket, damp locations				
A. Less than 10 square feet (0.93 m^2) and all dimension greater than 6 feet (1.83 m)	X	–	HB	X
B. 10 square feet or more, or a single dimension greater than 6 feet	X	200	HB	X

[a] Test is to be conducted in accordance with the Resistance to Impact Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[b] The maximum flame spread index is to be determined by the method described in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or in accordance with the Test for Surface Flammability of Materials Using a Radiant heat Energy Source, ASTM E162.

[c] The flammability classification is to 00 19 be determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

[d] Moisture resistance is to be determined in accordance with the Standard Test Method for Water Absorption of Plastics, ASTM D570, and the method for measuring water absorption of polymeric materials in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

7 Mechanical Assembly

7.1 An electrical component shall be securely mounted in place.

7.2 A surface-mounted temperature control shall be:

a) Secured indirectly to the storage tank by a bracket so as not to be readily displaced, as determined by the Mounting Test of Surface-Mounted Temperature Controls described in Section 31; or

b) Secured directly to the storage tank by positive fastening means such as screws or stud and nut.

8 Accessibility of Live Parts

8.1 A live electrical part of a water heater shall be so located or enclosed to reduce the risk of unintentional contact with an uninsulated live part.

8.2 An uninsulated live part shall not be exposed to contact by the user or service personnel adjusting the setting of a temperature-regulating thermostat, operating the resetting mechanism of a temperature-limiting control, operating a water drain valve, or performing a similar operation. This requirement applies even when the unit is marked as indicated in 48.1.

8.3 When a marking draws the attention of the user to an opening of any size for the insertion of a tool to adjust a thermostat, operate a reset mechanism, or any similar activity, the construction shall reduce the risk of contact with any uninsulated live part. The construction complies with this requirement when a 1/16 inch (1.6 mm) diameter rod does not contact any uninsulated live part when inserted through such an opening.

8.4 A barrier provided to reduce the risk of contact with a live part as required in 8.2 shall comply with all the following items. Thermal insulation shall not be employed for purposes of compliance with this requirement. The barrier shall:

a) Be an electrical insulating material having a temperature rating of at least 90°C (194°F);

b) Be at least 1/16 inch (1.6 mm) thick;

Exception: A barrier is not required to be at least 1/16 inch (1.6 mm) thick, when it is not less than 1/32 inch (0.8 mm) thick, and ribs or other means of providing mechanical strength, equivalent to a 1/16 inch (1.6 mm) thick barrier, are provided as determined by 32.1.

c) Extend at least 1/16 inch (1.6 mm) beyond any uninsulated live part (including any uninsulated portion of the conductor); and

d) Be secured in place by at least two independent means that have been subjected to the barrier pull test described in 32.2. Two parallel or symmetrical tabs are to be identified as two independent means of securement when they project from two different points on the barrier.

8.5 When a cover or barrier is provided to comply with 8.2, no more than 1/8 inch (3.2 mm) of an uninsulated conductor shall extend from a terminal covered by this cover or barrier after connection is made.

9 Wetting of Live Parts

9.1 An electrical part (including internal wiring) shall be located so that a leak at any point in the tank does not result in such a part being submerged in an accumulation of water. When a drain hole is provided for this purpose, it shall have an area no less than 0.049 square inch (31.61 mm^2).

9.2 A drain valve, if provided, shall be positioned or provided with tubing so that water does not contact any electrical parts.

10 Corrosion Resistance

10.1 General

10.1.1 An iron or steel part shall be made resistant to corrosion by enameling, galvanizing, plating, or other equivalent means when such corrosion results in a risk of fire, electric shock, or injury to persons.

Exception: When the oxidation of steel is not accelerated by exposure of the metal to air and moisture – thickness of metal and temperature also being factors – surfaces of sheet steel within an enclosure is not required to be corrosion resistant.

10.2 Storage tanks

10.2.1 A steel storage tank having a wall thinner than 1/4 inch (6.4 mm) shall have the inside surface resistant to corrosion.

Exception: This requirement does not apply to a storage tank that carries the American Society of Mechanical Engineers (ASME) Code symbols described in Storage Tank, Section 25.

11 Electrical Supply Connections – Permanent Connection

11.1 General

11.1.1 An electrical supply connection (branch-circuit wiring) is one that is made to the source of electrical supply when a heater is installed in the field.

11.1.2 A water heater shall have provision for the connection to a permanent wiring system in accordance with 11.3.1. The sheet metal surrounding the opening for permanent wiring connection shall be of such thickness or shall be formed or reinforced such that it has rigidity no less than that of a flat sheet of the same material having an average thickness no less than 0.053 inch (1.35 mm) if uncoated and 0.056 inch (1.42 mm) if galvanized.

Exception No 1: A small capacity storage tank water heater is not required to be permanently connected when it complies with Electrical Supply Connections – Cord Connection, Section 12.

Exception No. 2: A water heater rated 120 volts or less is not required to be permanently connected when it complies with Electrical Supply Connections – Cord Connection, Section 12.

11.2 Field-wiring compartment

11.2.1 A heater shall be provided with a compartment for connection to the supply (branch circuit) wiring. The volume of the compartment shall be no less than as indicated in Table 11.1. Each conductor extending outside the compartment and terminating inside the compartment is counted as one conductor. The thickness of any metal used for such a compartment shall be as indicated in Table 6.1 or Table 6.2.

Table 11.1
Minimum volume of field-wiring compartment

Size of conductor[a]		Free space within compartment for each conductor	
AWG	(mm^2)	$inch^3$	(cm^3)
14	(2.1)	2	(32.8)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.4)	3	(49.2)
6	(13.3)	5	(81.9)

[a] For 4 AWG (21.2 mm^2) or larger conductors, the minimum wire-bending space in Table 11.2 shall be provided.

Table 11.2
Minimum wire-bending space

Size of wire		Minimum bending space from connector, lug, knockout, or hole to wall[a]	
AWG	(mm^2)	inch	(mm)
14 – 10	(2.1 – 5.3)	Not specified	(–)
8 – 6	(8.4 – 13.3)	1-1/2	(38.1)
4 – 3	(21.2 – 26.7)	2	(50.8)
2	(33.6)	2-1/2	(63.5)

Table 11.2 Continued on Next Page

Table 11.2 Continued

Size of wire		Minimum bending space from connector, lug, knockout, or hole to wall[a]	
AWG	(mm^2)	inch	(mm)
1	(42.4)	3	(76.2)
[a] When a conductor is restricted from bending by a barrier or otherwise where it leaves the lug, the distance is to be measured from the end of the barrier.			

11.2.2 The depth of the compartment in the vicinity of any opening at which supply conductors enter shall be such that the required space for wire bending and manipulation remains between any wire connector, wiring lug, conduit knockout, or conduit hole and any wall of the wiring compartment that results in the wire bending, as specified in Table 11.2.

11.2.3 The size of the opening provided in the wiring compartment for the connection of conduit in the field, whether in the form of a knockout or an open hole, shall be sized to accommodate no less than the minimum trade size of conduit that is used, considering no less than 125 percent of the current the equipment draws, and the minimum conductor size that is required when aluminum supply conductors are used.

11.2.4 A terminal box or compartment for field connection to the power source shall be accessible for inspection of the connections without moving the installed heater.

11.2.5 The accessibility for inspection required in 11.2.4 is identified as intended when, after the heater has been installed in its intended operating position, the connections are examined without using a tool of other than the ordinary type, such as an offset screw driver, and similar tools, or disturbing the wiring in the terminal compartment. It is to be assumed that the rear of a water heater of the table-top type is in contact with a vertical wall, and that cabinets as high and as deep as the heater are in contact with the sides of the heater. The possibility of installation close to vertical walls is to be disregarded in evaluating a heater that is cylindrical in shape.

11.2.6 Wiring space or other compartments intended to enclose wires that are field installed shall be free of any sharp edge, burr, or fin that damages the conductor insulation.

11.2.7 Electrical (Junction) 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, as applicable.

11.2.8 Fittings for conduit and/or metal clad cable shall comply with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

11.3 Field-wiring terminals and leads

11.3.1 A water heater shall be provided with wiring terminals or with pigtail leads for connection to the supply conductors.

11.3.2 Each wiring terminal shall accommodate connection of supply conductors having an ampacity of no less than 125 percent of the current the equipment draws. When the current is 24 amperes or less, the terminal shall be able to accommodate the connection of a 10 AWG (5.3 mm^2) copper wire, or a 8 AWG (8.4 mm^2) aluminum wire when the equipment is to be connected with aluminum supply conductors.

11.3.3 A pigtail lead shall be no more than two wire sizes smaller than the supply conductor (copper) to which it is connected.

Exception: Multiple leads, when provided, are not required to comply with this requirement when the sum of the conductor cross-sectional areas of such leads for any given pole are equivalent to the size specified in this paragraph; however, in no case shall any pigtail lead be smaller than 14 AWG (2.1 mm^2).

11.3.4 The free length of a lead inside an outlet box or wiring compartment shall be at least 6 inches (152 mm) when the lead is intended for field connection to an external circuit.

11.3.5 A field-wiring terminal, that is in accordance with the marking described in 49.5, shall be capable of being used for the connection of either:

a) A copper supply conductor only; or

b) An aluminum or a copper supply conductor.

11.3.6 A wiring terminal shall be provided with a soldering lug bolted or held by a screw, or with a pressure wire connector.

Exception: A wire-binding screw is capable of being used at a wiring terminal for the connection of a 10 AWG (5.3 mm^2) or smaller conductor when upturned lugs or the equivalent are provided to hold the wire in position.

11.3.7 A wiring terminal shall be prevented from turning.

11.3.8 When a screw and washer construction is employed at a wiring terminal, the binding screw shall be no smaller than No. 10 (4.8 mm major diameter).

Exception: A No. 8 (4.2 mm) machine screw is capable of being used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor.

11.3.9 A terminal plate tapped for a wire-binding screw shall be of metal no thinner than 0.050 inch (1.27 mm). There shall be no fewer than two full threads in the metal.

Exception: A plate no thinner than 0.030 inch (0.76 mm) is capable of being used when the tapped threads have equivalent mechanical strength.

11.3.10 If required to provide two full threads for the binding screw, a terminal plate shall have the metal extruded at the tapped hole.

11.3.11 Upturned lugs or a cupped washer, when employed, shall be capable of retaining a 14 AWG (2.1 mm^2) or larger conductor under the head of the screw or washer provided to hold the wire in position.

11.3.12 A wire-binding screw shall thread into metal.

11.3.13 A water heater intended for permanent connection to a grounded conductor of a power supply circuit shall have one terminal or lead identified for the connection of such a conductor. No switch or overcurrent protective device of the single pole type shall be connected in the grounded conductor.

11.3.14 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059.

11.3.15 Electrical Quick Connect Terminals shall comply with the Standard for Electrical Quick Connect Terminals, UL 310.

12 Electrical Supply Connections – Cord Connection

12.1 Power supply cords

12.1.1 With respect to the Exceptions of 11.1.2, a storage tank water heater intended for cord and plug connection to the supply circuit shall be provided with damp location, hard or extra hard usage flexible cord, such as Type S, SO, ST, STO, SJ, SJT, SJTO, HS, or HSO cord as described in the National Electrical Code, ANSI/NFPA 70. The length of the cord external to the water heater, measured to the face of the attachment plug, shall be no less than 2 feet (0.61 m) nor more than 6 feet (1.83 m).

12.1.2 An attachment plug provided on a small capacity storage tank water heater shall be of the grounding type and shall be rated in accordance with Table 12.1 and shall comply with the Standard for Attachment Plugs and Receptables, UL 498.

Table 12.1
Attachment plug rating and supply cord size

Maximum load (amperes)		Supply cord (AWG)	Attachment plug rating (amperes)
More than	No more than		
0	10	18	15 or 20
10	12	16	15 or 20
12	13	16	20
13	16	14	20
16	18	12	30
18	24	10	30
24	25	10	40
25	30	8	40
30	32	6	40
32	40	6	50

12.1.3 A power supply cord provided on a small capacity storage tank water heater shall have conductors of the size specified in Table 12.1.

12.1.4 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62.

12.2 Bushings

12.2.1 At a point where a power supply cord passes through an opening in a wall, barrier, or enclosing case:

a) There shall be a bushing or equivalent that is secured in place; or

b) The opening shall have a smooth, rounded surface against which the cord bears.

12.2.2 A soft bushing of rubber, neoprene, or polyvinyl chloride shall not be used at any point in a water heater unless the bushing is not relied upon to protect the cord insulation and the edges of the hole in which the bushing is mounted are smooth and free from burrs, fins, or any sharp edge.

12.3 Strain relief

12.3.1 Strain relief, other than a knot in a power supply cord, shall be provided such that mechanical stress on a power supply cord is not transmitted to terminals, splices, or internal wiring, as determined by the Strain Relief Test described in Section 37.

12.3.2 Means shall be provided to prevent the power supply cord from being pushed into the enclosure of a water heater through the cord entry hole when such displacement:

a) Subjects the cord to mechanical damage;

b) Exposes the cord to a temperature higher than that for which it is rated; or

c) Reduces spacings to values below the minimum values specified in Table 13.1.

To determine compliance, the supply cord shall be tested in accordance with Section 38, Push Back Relief Test.

13 Electrical Spacings

13.1 General

13.1.1 The electrical spacings in a water heater shall be in accordance with Table 13.1.

Exception No. 1: The spacing requirements in Table 13.1 do not apply to the inherent spacings of a component, as such spacings are judged under the individual requirements for the component. However, the electrical clearance resulting from the assembly of the component into the heater unit, including spacings from parts of such a component to a dead metal part or enclosure, shall be as indicated in Table 13.1.

Exception No. 2: At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) is capable of being used between uninsulated live parts of opposite polarity and between uninsulated live parts and dead metal parts when:

a) The heater is rated 250 volts or less; and

b) The points in question are at other than wiring terminals.

Table 13.1
Minimum electrical spacings

Location in water heater	Rated voltage	Minimum spacing			
		Through air		Over surface	
		inch	(mm)	inch	(mm)
Between uninsulated live parts of opposite polarity and between uninsulated live parts and dead metal parts	250 or less	1/16	(1.6)	1/16	(1.6)
	More than 250	1/4	(6.4)	1/4	(6.4)
At wiring terminals, and not connecting straps or busses extending from such terminals, between:					

Table 13.1 Continued on Next Page

Table 13.1 Continued

Location in water heater	Rated voltage	Minimum spacing			
		Through air		Over surface	
		inch	(mm)	inch	(mm)
A. Uninsulated metal of terminal and enclosure metal	250 or less	1/2	(12.7)	1/2	(12.7)
	More than 250	1/2	(12.7)	1/2	(12.7)
B. Uninsulated terminal parts of opposite polarity or between uninsulated terminal parts and metal other than the enclosure that are grounded in service	250 or less	1/4	(6.4)	3/8	(9.5)
	More than 250	3/8	(9.5)	1/2	(12.7)

13.1.2 An insulating lining, barrier of fiber, or similar material employed where spacings otherwise are less than the required values shall be no less than 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it is not adversely affected by arcing. As an alternative to air alone, fiber no less than 1/64 inch (0.4 mm) thick shall be used in conjunction with an air spacing of no less than half the required spacing.

Exception: Insulating material is capable of being used at a thickness less than specified when, upon investigation, it is determined that it is not adversely affected by arcing.

13.1.3 Unless it is protected from mechanical damage during assembly and intended use, a barrier of mica shall be at least 0.01 inch (0.25 mm) thick.

13.2 Reduction of spacings due to turning or shifting

13.2.1 Wire mesh used to secure thermal insulation in a heater not provided with an outer enclosure shall be secured in place so that it does not shift or distort during shipment, installation, or operation of the heater to the extent that spacings to uninsulated live parts are reduced below the minimum values specified in Table 13.1.

13.2.2 An uninsulated live part shall be secured in place so that it is prevented from turning or shifting to such extent that spacings are reduced below the minimum values specified in Table 13.1.

13.2.3 Unless the construction has been investigated and found to prevent shifting or turning, friction between surfaces shall not be used to prevent shifting or turning of live parts. A lock washer is capable of being used for this purpose. Thermal insulation alone shall not be used as a means for securing an uninsulated live part in place.

14 Grounding

14.1 General

14.1.1 An exposed dead metal part that becomes energized and a dead metal part within the enclosure that is exposed to contact during service and that becomes energized shall be conductively connected:

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

b) To the equipment-grounding terminal or lead.

Exception: The requirement for grounding does not apply to:

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

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

2) Positively separated from all electrical components.

b) A panel or cover that is insulated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material at least 0.028 inch (0.71 mm) thick and secured in place; and

c) A panel or cover that does not enclose uninsulated live parts and is positively separated from other electrical components.

14.1.2 Unless the dead metal parts described in 14.1.1 are bonded together by mechanical fasteners, an individual bonding conductor or strap shall be used for this purpose.

14.1.3 The bonding conductor shall be of material intended for use as an electrical conductor and resistant to corrosion. An individual bonding conductor or strap shall be installed so that it is not subject to mechanical abuse.

14.1.4 The bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, brazing, or welding. The bonding connection shall penetrate nonconductive coatings such as paint.

14.1.5 A separate component-bonding conductor shall be no smaller than the size specified in Table 14.1.

Exception No. 1: For a branch circuit overcurrent protective device rated no more than 30 amperes, a conductor is not required to comply with the requirement when the bonding connection does not open when carrying twice the rated current of the branch circuit overcurrent protective device for 2 minutes.

Exception No. 2: For a branch circuit overcurrent protective device rated more than 30 amperes and no more than 50 amperes, a conductor is not required to comply with this requirement when the bonding connection does not open when carrying twice the rated current of the branch circuit overcurrent protective device for 4 minutes.

Table 14.1
Grounding/bonding conductor size

Maximum rating or setting of automatic overcurrent device in circuit amperes[a]	Size of grounding/bonding conductor[b]			
	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 – 50	10	(5.3)	8	(8.4)

[a] The grounding conductor in the cord for a cord connected supply shall be the same or greater size as the current-carrying conductors.

[b] Or equivalent cross-sectional area.

14.1.6 The resistance of the grounding path between a dead metal part and the equipment grounding terminal or point of attachment of the wiring system shall be no more than 0.1 ohm as measured in accordance with Grounding-Circuit Resistance Measurement Test, Section 34.

14.1.7 A sliding metal top of a heater of the table-top variety is not required to be bonded to the remainder of the enclosure unless:

a) Switches, thermostats, wiring, or other electrical components are secured to the top; or

b) When the top is in place, electrical components contact it under conditions of distortion that are encountered in service.

When neither condition prevails, the sliding contact is capable of being used for the required electrical bonding connection.

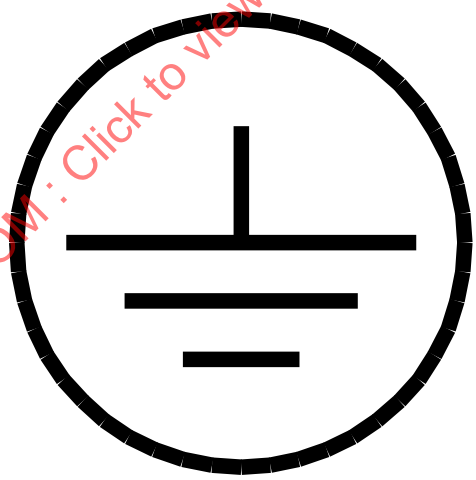
14.1.8 A field-wiring terminal intended for the connection of an equipment grounding conductor shall be identified by:

a) Use of a green colored head that is hexagonal shaped or slotted, or both; or

b) The grounding symbol illustrated in Figure 14.1 on or adjacent to the terminal or on a wiring diagram provided on the product.

Figure 14.1

Grounding symbol



14.1.9 A pressure wire connector intended for the connection of such a conductor shall be plainly identified by:

a) Being marked "G," "GR," "GND," "Ground," "Grounding," or the like;

b) A marking on a wiring diagram provided on the water heater; or

c) The grounding symbol illustrated in Figure 14.1 on or adjacent to the terminal or on a wiring diagram provided on the product.

14.1.10 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the intended size.

14.2 Conductor identification

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

14.2.2 A terminal intended for the connection of the grounded power supply conductor shall be of, or plated with, metal that is substantially white in color, and the terminal shall be readily distinguishable from the other terminal or terminals, or identification of the terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. The surface of a lead intended for the connection of a grounded power supply conductor shall be white or gray, and shall be readily distinguishable from the other lead or leads.

15 Reduction of Risk of Injury

15.1 Sharp edges

15.1.1 An edge, projection, corner of the enclosure, opening, or frame shall be smooth and rounded to the degree required to reduce the risk of causing a cut type injury when contacted during intended use and routine user maintenance of the water heater.

15.1.2 The intended use and routine user maintenance referred to in 15.1.1 includes cleaning of the outer enclosure, periodic draining of water from the tank, and similar operations, and does not include removal of a cover by means of a tool for the purpose of gaining access to a temperature control.

15.2 Stability

15.2.1 The stability of a water heater shall be such that it is not overturned when tipped through an angle of 10 degrees from its normal, upright position.

15.2.2 The stability of a water heater is to be investigated only when it has flexible water connections or is manually filled, and when the height of the center of gravity of the filled heater, above the supporting surface, is more than twice the smallest dimension of the base.

15.3 Surface temperatures

15.3.1 A surface that is subject to contact during operation, or that is capable of being contacted during user maintenance, shall not attain a temperature greater than the limits shown in Table 28.2.

16 Overcurrent Protection

16.1 A water heater rated more than 48 amperes and employing resistance heating elements shall have the heating elements on subdivided circuits. Each subdivided load shall not exceed 48 amperes and shall be protected at no more than 60 amperes.

16.2 The overcurrent protection devices required in 16.1 shall be provided by the manufacturer as an integral part of the water heater or shall be provided by the manufacturer as a separate assembly for independent mounting for use with the water heater. When the overcurrent protection devices are provided as a separate assembly, the water heater and the overcurrent protection assembly shall be marked as required in 49.7 and 49.8, respectively.

16.3 The overcurrent protection specified in 16.1 and 16.2 shall be of a type rated for branch circuit protection. A cartridge fuse used for this purpose shall be a Class CC, G, H, J, K, R, or T. A plug fuse shall be used only in circuits of 125 volts maximum.

16.4 Fuseholders shall comply with one of the following:

a) The Standard for Fuseholders – Part 1: General Requirements, UL 4248-1 and the applicable Part 2 (e.g. UL 4248-9 for Class K).

16.5 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and the applicable UL 248 Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another applicable UL standard for fuses are considered to comply with this requirement.

16.6 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

17 Materials in Contact with Water

17.1 General

17.1.1 A nonmetallic material in contact with water shall comply with the requirements of the National Sanitation Foundation Standard for Plastic Piping System Components and Related Materials, ANSI/NSF No. 14.

17.2 Dip tubes

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

17.2.2 A dip tube shall have a specific gravity greater than 0.94 and, when the specific gravity is less than 1.0, the dip tube shall be held in place by a positive means that limits any vertical displacement to no more than 1/4 inch (6.4 mm).

17.2.3 A nonmetallic dip tube shall comply with the tests described in Nonmetallic Dip Tube Tests, Section 36.

Exception: Nonmetallic dip tubes that comply with ANSI Z21.98/CSA 4.10, "Non-metallic dip tubes for use in water heaters", or other equivalent nationally recognized standard(s) are not required to meet the requirements of Section 36.

17.3 Polymeric storage tank liner

17.3.1 A polymeric liner provided in a storage tank shall have a water vapor transmission (WVT) rate of less than 5 when measured in accordance with the Test Methods for Water Vapor Transmission of Materials, ASTM E96.

18 Current-Carrying Parts

18.1 A part used to carry current shall be of copper or copper alloy, aluminum, or equivalent metal.

18.2 Stainless steel and other corrosion-resistant alloys used for current-carrying parts in a water heater have no restriction as to temperature. Plated iron or steel is capable of being used for current-carrying

parts when the material is subjected to a temperature higher than 100°C (212°F), and unplated iron or steel shall not be used.

18.3 The surface of an aluminum current-carrying part shall be coated at a clamped joint with tin, silver, nickel, or cadmium.

19 Internal Wiring

19.1 The insulation on a conductor shall be able to withstand the temperature to which the insulation is subjected in service. Wire employed for internal wiring shall be rated for the intended operating temperature and application.

19.2 A splice or connection shall be mechanically secure and shall provide electrical contact.

19.3 A splice shall be provided with insulation equivalent to that on the wires involved to maintain permanence of spacing between the splice and uninsulated metal parts.

19.4 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts, shall be terminated at each end by a method intended for the combination of metals involved at the connection point.

19.5 When a wire-binding screw construction, or a pressure wire connector is used as a terminating device for aluminum wire, it shall be intended for use with aluminum under the conditions involved (for example, temperature and heat cycling).

19.6 Wiring within an enclosure, compartment, or raceway shall be located or protected to reduce the risk of contact with any sharp edge, burr, fin, or moving part, that damages the conductor insulation.

19.7 When stranded internal wiring is connected to a wire-binding screw, loose strands of the wire shall be prevented from contacting any other uninsulated live part that is not always of the same polarity as the wire, and from contacting any dead metal part. Methods to accomplish this include using pressure terminal connectors, soldering lugs, or crimped eyelets, by soldering all strands of the wire together, or by other equivalent means.

19.8 Wiring employing wax impregnated insulation shall not contact a control unit other than at the point of connection of the metal conductor in a wire to a terminal of a control. The wire shall leave the terminal in a downward direction.

19.9 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B or the Standard for Splicing Wire Connectors, UL 486C.

19.10 Thermoplastic wiring material shall comply with the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

20 Electrical Insulation

20.1 Insulating washers and bushings that are parts of a water heater, and bases or supports for the mounting of current-carrying parts shall be of a moisture-resistant material that is not affected adversely by the temperatures to which the parts are subjected in use.

20.2 Electrical insulating material employed in a heater is to be judged with respect to its intended use. Materials such as mica, some molded compounds, and certain refractory materials are usually intended for use as the sole support of uninsulated live parts. Certain other materials that are not intended for

general use, such as magnesium oxide, shall be used only in conjunction with other insulating materials rated for use or when located and protected so that mechanical injury and the absorption of moisture do not occur. When an investigation is required to determine the acceptability of a material, consideration is to be given to mechanical strength of the material, its dielectric characteristics, insulation resistance, heat-resistant characteristics, the degree to which it is enclosed or protected, and any other features that affects the risk of fire, electric shock, or injury to persons in conjunction with the conditions of actual service.

20.3 The mounting or supporting of small, fragile insulating parts, screws, or other fastenings shall not be so tight as to result in the cracking or breaking of these parts as a result of expansion and contraction.

21 Thermal Insulation

21.1 General

21.1.1 Thermal insulation in direct contact with a live part shall be glass wool or equivalent material that is nonconductive, nonabsorbent, resistant to combustion, and that has been shown by investigation to be intended for such use. Thermal insulation in contact with wiring shall be nonabsorbent and resistant to combustion.

21.1.2 Thermal insulation not in contact with a live part or wiring shall be material that has been shown by investigation to be intended for such use.

Exception: The investigation referred to in this paragraph is to be waived when each water heater is subjected to a routine production line dielectric voltage-withstand test in accordance with 30.1. Alternatively, a 1 second application of a test potential of 1500 volts is to be made on each heater rated at 250 volts or less, and a 1 second application of a test potential of 2500 volts is to be made on each heater rated at more than 250 volts.

21.2 Polymeric foam

21.2.1 When polymeric foam is used as thermal insulation:

a) The foam shall be completely enclosed by sheet-metal having a thickness as indicated in Table 6.1 or by a polymeric outer jacket that complies with 6.3.2;

b) All enclosure fastening means shall be mechanically secured;

c) The foam shall not be in contact with the internal wiring of the water heater;

d) The foam shall be located no less than 2 inches (50.8 mm) from any electrical component, such as a thermostat or heating element; and

e) The foam shall be rated for the temperatures involved as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

Exception No. 1: With regard to (a), foam that has a flame spread classification of 25 or less as shown by the requirements in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, is not required to be enclosed in metal.

Exception No. 2: As an alternative to (a), polyvinyl chloride, polyethylene, or the equivalent shall be used in place of enclosure metal at a plumbing connection when the opening at the connection does not exceed three times the diameter of the pipe.

Exception No. 3: With regard to (c), the foam shall not be in contact with internal wiring unless the entrance and exit wiring holes are sealed with polyvinyl chloride grommets or sealing compound.

Exception No. 4: With regard to (c) and (d), the foam shall not be in contact with internal wiring and the electrical components shall not be located less than 2 inches from the foam unless:

a) The foam has a flame class rating of HF-1 or HF-2 in accordance with the Appendix A included with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; or

b) No fire occurs as a result of the electrical disturbance test described in Electrical Disturbance Test of Foam Thermal Insulation, Section 39.

Exception No. 5: With regard to (e), a foam is not required to be temperature rated as specified in UL 746B if it is not subjected to temperatures exceeding the temperature requirements documented by the foam manufacturer.

22 Heating Elements

22.1 General

22.1.1 A heating element shall be supported so that it is not subjected to mechanical abuse and contact with outside objects.

22.1.2 A wraparound element shall be secured in place so that it does not loosen. An investigation is to determine whether the construction complies with this requirement.

22.2 Sheathed elements

22.2.1 A sheathed heating element shall comply with the requirements in the Standard for Sheathed Heating Elements, UL 1030.

22.2.2 Unless of the immersion type, a sheathed heating element shall be in an enclosure that complies with the requirements in Table 6.1.

23 Temperature-Regulating Controls

23.1 A water heater shall be provided with a temperature regulating control and be subjected to the water temperature test specified in 29.1. The water heater complies with the test when the control limits the water temperature to 85°C (185°F) or less.

23.1.1 An electro-mechanical temperature-regulating control shall comply with the water temperature regulating control requirements of the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or the Standard for Limit Controls, UL 353.

23.1.2 An electro-mechanical temperature-regulating control shall be investigated and found acceptable for continuous operation under rated electrical load for 30,000 cycles of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±5.6°C).

23.1.3 An electronic temperature-regulating control with switched outputs that relies on hardware circuitry only to regulate or maintain the temperature within the limits specified in 23.1 shall comply with the requirements of :

a) The Standard for Limit Controls, UL 353, or the water temperature regulating control requirements of the Standard for Temperature-Indicating and Regulating Equipment, UL 873, and;

b) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, with no single points of failure permitted.

23.1.4 An electronic temperature-regulating control that relies on software to regulate or maintain the temperature within the limits specified in 23.1 shall, in addition to 23.1.3, comply with the requirements for software Class 1 in accordance with the Standard for Software in Programmable Components, UL 1998.

23.1.5 Electronic temperature-regulating controls shall be found acceptable for continuous operation under rated electrical load for 30,000 cycles of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±5.6°C).

23.1.6 As an alternate to 23.1.1 – 23.1.5, a temperature regulating control shall be investigated to the Standard for Automatic Electrical Controls; Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9 utilizing the declarations described in Table 23.1.

Table 23.1
Temperature-regulating (operating) control parameters

UL 60730-1, Table 1 item number[a]	Information	Control requirement
6	Purpose of control	Thermostat
7	Type of load controlled	AC heater (resistive load) AC Pump (motor load)
27	Number of Automatic cycles (A)	30,000
29	Type of disconnection or interruption	Micro-Disconnection (B) Electronic Disconnection (Y)
39	Type 1 or Type 2 action	Type 2
40	Additional features	Automatic reset
41	Manufacturing Deviation, maximum	±7°F (±3.9°C)
42	Drift	Not vary from the as-received temperature by more than 10°F (5.6°C) of the setpoint temperature.
48	Operating value	85°C (185°F) maximum setpoint normal operation
49	Pollution degree	Pollution degree 2 [e]
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains borne perturbations, magnetic and electromagnetic disturbances	Required[b]
60	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category III[c]
69	Software Class	B[d]
74	External load and emission control measures to be used for test purposes	Must be specified
91	Fault reaction time	Must be specified
92	Class or classes of control function(s)	B

[a] This table should be used as a correlation for the parameters specified for the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 and the Standard for Limit Controls, UL 353 evaluations.

Table 23.1 Continued on Next Page

Table 23.1 Continued

UL 60730-1, Table 1 item number[a]	Information	Control requirement
[b] For the purpose of the tests specified in the Electromagnetic compatibility (EMC) requirements – immunity Annex H, Section 26 of the Standard for Automatic Electrical Controls, Part 1: General Requirements, UL 60730-1, the products covered by this Standard should be considered as: a) Installation Class 3 for indoor use, or 4 for outdoor use (See the Explanatory notes for surge immunity test, Annex R of UL 60730-1); b) Overvoltage Category III applies for permanently-connected equipment. For cord-connected equipment, Overvoltage Category II applies; c) Test Level 3. [c] Overvoltage Category III applies for permanently-connected equipment. For cord-connected equipment, Overvoltage Category II applies. [d] Does not apply to electromechanical controls or controls with protection implemented in hardware only – see Item 92. [e] Pollution Degree 2 applies except when the manufacturer declares Pollution Degree 3 due to exposure of condensation or water to the control during normal operation.		

23.2 A temperature-regulating thermostat shall have no marked dial setting more than 77°C (171°F) and shall be inherently designed or provided with a stop to prevent its adjustment to a higher temperature setting.

23.3 The temperature-regulating control required by 23.1 shall be set before leaving the factory to a control position corresponding to a water temperature no higher than 51.7°C (125°F).

Exception: When the water heater is equipped with a thermostatic mixing valve in addition to the temperature regulating control, the factory setting of the water temperature mixing valve shall be no higher than 51.7°C (125°F) and the temperature-regulating control shall be factory set no higher than 60°C (140°F).

23.4 When the water heater is equipped with a thermostatic mixing valve, the mixing valve shall not be used as the sole means of water temperature regulation to meet the requirements of 23.1 and the mixing valve shall comply with the requirements of ASSE 1017 “Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems” or an equivalent nationally recognized standard.

24 Temperature-Limiting Controls

24.1 A water heater with a tank closed to the atmosphere shall be equipped with a factory installed direct or indirect acting manually reset temperature-limiting control that:

a) Is functionally separate from the temperature-regulating control;

b) Opens all ungrounded power supply conductors to the heater;

c) Is located such that the manual reset actuator is readily accessible to the user;

d) Limits the water temperature to no higher than 99°C (210°F) when tested as described in 29.2 regardless of the position of the actuating handle or button lever (that is, the control is "trip free"); and

e) Does not automatically reclose at temperatures above 0°C (32°F).

24.1.1 An electro-mechanical control shall comply with the Standard for Limit Controls, UL 353, or the water heater limiting control requirements in the Standard for Temperature-Indicating and Regulating Equipment, UL 873.

24.1.2 A manually reset electro-mechanical temperature-limiting control shall be investigated and found acceptable for continuous operation for 6,000 cycles (1,000 under rated electrical load and 5,000 without) of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±5.6°C).

24.1.3 An electronic temperature-limiting control with switched outputs that only relies on hardware circuitry to limit the temperature within the limits specified in 24.1 shall comply with the requirements of:

a) The Standard for Limit Controls, UL 353, or the water heater limiting control requirements in the Standard for Temperature-Indicating and Regulating Equipment, UL 873, and;

b) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 with no single points of failure permitted.

24.1.4 An electronic temperature-limiting control that relies on software to limit the temperature within the limits specified in 24.1 shall comply with the requirements for software Class 2 in accordance with the Standard for Software in Programmable Components, UL 1998.

24.1.5 An electronic temperature-limiting control shall be investigated and found acceptable for continuous operation for 6,000 cycles (1,000 under rated electrical load and 5,000 without) of operation without any mechanical or electrical breakdown, impairment of operation, or any apparent damage. Any change in calibration as a result of the continued operation test shall not exceed ±10°F (±5.6°C).

24.1.6 As an alternate to 24.1.1 – 24.1.5, temperature-limiting controls shall be investigated to the 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 utilizing the declarations specified in Table 24.1.

Table 24.1
Temperature-limiting (Thermal cutout, protective) control parameters

UL 60730-1, Table 1 item number [a]	Information	Control requirement
6	Purpose of control	Manually reset thermal cut-out
7	Type of load controlled	AC heater (resistive load) AC Pump (motor load)
27	Number of Automatic cycles (A)	6000; 1000 with load, 5000 without load
29	Type of disconnection or interruption	Micro-Disconnection (B)
39	Type 1 or Type 2 action	Type 2
40	Additional features	Automatic reset
41	Manufacturing Deviation, maximum	±7°F (±3.9°C)
42	Drift	Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or by more than 10°F (5.6°C) of the setpoint temperature, whichever is the greater.
48	Operating value	99°C (210°F) maximum setpoint

Table 24.1 Continued on Next Page

Table 24.1 Continued

UL 60730-1, Table 1 item number [a]	Information	Control requirement
49	Pollution degree	Pollution degree 2[e]
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains borne perturbations, magnetic and electromagnetic disturbances	Required[b]
60	Surge immunity	IEC 61000-4-5 installation Class 3, Overvoltage category III[c]
69	Software Class	C[d]
74	External load and emission control measures to be used for test purposes	Must be specified
91	Fault reaction time	Must be specified
92	Class or classes of control function(s)	C

[a] This table should be used as a correlation for the parameters specified for the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 and the Standard for Limit Controls, UL 353 evaluations.

[b] For the purpose of the tests specified in the Electromagnetic compatibility (EMC) requirements - immunity Annex H, Section 26 of the Standard for Automatic Electrical Controls, Part 1: General Requirements, UL 60730-1, the products covered by this Standard should be considered as:

a) Installation Class 3 for indoor use, or 4 for outdoor use (See the Explanatory notes for surge immunity test, Annex R of UL 60730-1);

b) Overvoltage Category III applies for permanently-connected equipment. For cord-connected equipment, Overvoltage Category II applies;

c) Test Level 3.

[c] Overvoltage Category III applies for permanently-connected equipment. For cord-connected equipment, Overvoltage Category II applies.

[d] Does not apply to electromechanical controls or controls with protection implemented in hardware only – see Item 92.

[e] Pollution Degree 2 applies except when the manufacturer declares Pollution Degree 3 due to exposure of condensation or water to the control during normal operation.

24.2 With reference to 24.1(e), a control that is either single pole or multipole is capable of being used when there is one pole in each ungrounded power supply conductor. The requirement in that item applies regardless of the number of power supply circuits connected to the heater.

24.3 The temperature-limiting control circuit shall be designed such that a malfunction of any component in the temperature-regulating or other operating control circuit will not adversely affect the operation of the safety limit control circuit.

24.4 When the temperature-limiting control is in the control circuit of a magnetic contactor or relay, such contactor or relay shall be wired so that it is not actuated by a temperature-regulating thermostat.

24.5 Components including sensors, contactors and sequence controllers that are operated by the temperature-limiting control shall be rated for 100,000 cycles of operation and shall be arranged to result in the direct opening of that circuit, whether the switching mechanism is integral with the sensing element or remote from the element.

25 Storage Tank

25.1 A storage tank shall be marked with the symbol of the Boiler and Pressure Vessel Code, ANSI/ASME BPV, consisting of the Code FW, H, HLW, or U in a clover leaf.

Exception No. 1: This requirement does not apply to a water heater having a tank open to the atmosphere.

Exception No. 2: A metal storage tank is not required to be marked with the ASME code symbol when the tank complies with the storage tank hydrostatic pressure test requirements specified in 35.1 and 35.2.

Exception No. 3: A fiberglass-reinforced plastic storage tank is not required to be marked with the ASME code symbol when the tank complies with the storage tank hydrostatic pressure test specified in 35.1 and 35.3.

25.2 The hydrostatic test specified in 25.1 shall be conducted in accordance with Storage Tank Hydrostatic Pressure Test, Section 35.

25.3 A storage tank shall have an opening for installation of a temperature and pressure relief valve. The opening:

a) Shall be located:

1) In the top of the tank; or

2) With its center line in the upper 6 inches (152 mm) of the side.

b) Shall be separate from the openings for water connections.

c) Shall be threaded in conformity with the requirements for Pipe Threads, ANSI B2.1.

d) Shall accommodate a 1/2 inch (12.7 mm) or larger trade-size pipe when the rating is less than 4.5 kilowatts, and shall accommodate a 3/4 inch (19.1 mm) or larger trade size pipe when the rating is 4.5 kilowatts or more.

PERFORMANCE

26 Power Input Test

26.1 The power input to a water heater shall be no more than 105 percent of its marked input rating.

26.2 To determine compliance with 26.1, the heater is to be connected to a supply circuit of voltage as specified in 26.3, and the power input is to be measured with the heater operating under full load conditions as described in 28.2.1 – 28.2.9.

26.3 The supply voltage for the test described in 26.2 is to be as follows:

a) For a heater rated 120 volts or less, or with a range of voltages (such as 105 – 110 volts) where no voltage within the range exceeds 120 volts, the test voltage is to be 120 volts.

b) For a heater with a single voltage rating that exceeds 120 volts, the test is to be conducted at the rated voltage. When the single voltage rating falls within the range of 220 – 240, 254 – 277, or 440 – 480 volts, the test is to be conducted at the maximum voltage in the particular range.

c) For a heater with a range of voltages, any part of which exceeds 120 volts, the test is to be conducted at the highest voltage of the rated range.

27 Insulation Resistance Test

27.1 A heating element employing insulating material that is affected adversely by moisture shall have an insulation resistance of no less than 50,000 ohms after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

27.2 Insulation resistance is to be measured by means of a high resistance voltmeter having an input impedance of no less than 30,000 ohms, using a 250 volt direct current circuit. The voltmeter is used to measure voltage drop across the resistance of the insulation, and the insulation resistance is then to be calculated.

28 Temperature Test

28.1 General

28.1.1 A water heater shall be subjected to the temperature tests described in 28.2.1 – 28.4.4.

28.2 Maximum load

28.2.1 A water heater shall be subjected to a heating test as specified in 28.2.2 – 28.2.9. The water heater complies with the requirement when the temperature rise at specific points is no more than specified in Table 28.1, or when the temperature at any other point is not so high as to result in a fire or to affect adversely any material employed in the heater.

Table 28.1
Maximum temperature rises

	Materials and components	°C	(°F)
1.	Varnished cloth insulation	60	(108)
2.	Class CC, G, J, and T fuses	85[a]	(153[a])
3.	Fuses other than Class CC, G, J, and T	65[a]	(117[a])
4.	Fiber used as electrical insulation	65	(117)
5.	Wood or other combustible material including the surfaces supporting or adjacent to the heater	65	(117)
6.	Phenolic composition used as electrical insulation or as a part whose failure results in a risk of fire or electric shock[b]	125	(225)
7.	Insulated wire or cord	25 less than its established temperature rating[c]	(75) less than its established temperature rating[c]
8.	At any point within a terminal box or compartment of a permanently connected appliance[d]	35	(63)
9.	Sealing compounds	e	(e)
10.	Capacitors	25 less than marked limit	(75) less than marked limit
11.	Copper or copper base alloy conductor (bare or insulated) without tinning, nickel coating, or silver plating, except as noted in item 12	175	(315)
12.	A termination of a copper or copper base alloy conductor in a pressure terminal connector unless both are tinned, nickel coated, or silver plated.	125	(225)

Table 28.1 Continued on Next Page

Table 28.1 Continued

Materials and components	°C	(°F)
[a] A fuse that has been investigated and found intended for use at a higher temperature shall be used at that temperature.		
[b] The limitation on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and determined to have special heat-resistant properties.		
[c] Inside a water heater, the temperature rise on a wire or cord shall be greater than the specified maximum rise when the insulation on each individual conductor is protected by supplementary insulation, such as braid, wrap, tape, or close-fitting tubing that is rated for the temperature and type of insulation provided.		
[d] It is to be assumed that field installed conductors or splices are capable of touching the tank or other parts located in or back of the terminal box or compartment even though such components are covered with thermal insulation.		
[e] Unless the material is thermal-setting, the maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined by the Test Method for Softening Point by Ring-and-Ball Apparatus, ASTM E28.		

28.2.2 To determine compliance with 28.2.1, the heater is to be tested under conditions approximating those of intended operation, and as noted in this section. It is to be supported on a horizontal softwood surface and placed in a wall angle of 90 degrees formed by two black-painted, vertical surfaces of 3/8 inch (9.5 mm) thick plywood having width and height such that they extend no less than 2 feet (610 mm) beyond the physical limits of the heater. The heater is to be located as close to the sides of the wall angle as its construction permits so that maximum heating of the walls occurs. Temperatures are to be observed on nearby surfaces, on the supporting surface, at points of support, and at other points as required. The supply voltage is to be as described in 26.3.

28.2.3 The temperature of the cold water supply is to be that at which the water is obtained from the community water main.

28.2.4 All thermostats are to be set to give the maximum water temperature, and the heater is to be operated until constant temperatures are attained. Temperature readings are to be obtained by thermocouples, as described in 28.2.8.

28.2.5 Unless a heater involves unusual features of design or construction, it is to be assumed that temperatures have become constant after the heater has been operated as follows. After a full tank of water has been heated to the temperature at which the temperature-regulating thermostats open, one-fourth of the hot water is to be drawn off and replaced promptly with cold water. The appliance is then to be allowed to heat again until the thermostats open, at which time temperatures are to be observed immediately.

28.2.6 All values for temperature rises in Table 28.1 are based on an assumed ambient temperature of 25°C (77°F). However, tests are conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

28.2.7 Temperatures are to be measured by thermocouples consisting of wires no larger than 24 AWG (0.21 mm^2) and no smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to employ thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer type instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are required.

28.2.8 A temperature is determined to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (and no less than 5-minute intervals), indicate no change. The thermocouples and related instruments are to be accurate and calibrated in accordance with laboratory practice. The thermocouple wire is to conform with the requirements listed in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

28.2.9 A thermocouple junction and adjacent thermocouple lead wire are to be held in thermal contact with the surface of the material whose temperature is being measured. In most cases, the required thermal contact results from taping or cementing the thermocouple in place and, when a metal surface is involved, brazing or soldering the thermocouple to the metal is required.

28.3 Surface temperatures

28.3.1 During the test described in 28.2.1 – 28.2.9, temperature readings are to be observed on surfaces of the heater that are accessible to contact by persons while the heater is in use. The surface temperatures comply with the requirement when these temperatures do not exceed the maximum values given in Table 28.2.

Table 28.2
Maximum surface temperatures

Surface material	°C	(°F)
Bare or painted metal	67	(153)
Porcelain enamel	71	(160)
Glass	78	(172)
Plastic[a]	83	(182)

NOTE – All temperature limits are based on 25°C (77°F) ambient temperature.

[a] Includes plastic with a metal plating no more than 0.005 inch (0.13 mm) thick; and metal with a plastic or vinyl covering no less than 0.005 inch thick.

28.4 Dry operation

28.4.1 When the conditions of maximum load as described in 28.2.1 – 28.2.9 do not represent all the conditions of abnormal operation that occur in actual service, a water heater shall be subjected to the test specified in 28.4.2.

Exception: The dry operation test described in 28.4.2 is not to be conducted on a water heater that utilizes only immersion type sheathed heating elements, or on a water heater that has a metal outer jacket.

28.4.2 A heating test is to be conducted with the water heater operating dry, and with the thermostats in the circuit and set for maximum heating. The acceptability of the heater is to be determined from the results observed immediately after the first operation of the temperature-regulating thermostats.

28.4.3 When operated under such conditions, the heater complies with the requirement when there is no emission of flame or molten metal, or when the operation of the water heater does not result in the glowing or flaming of combustible material upon which the heater is mounted or near which the heater is installed.

28.4.4 After the completion of the test described in 28.4.1, the risk of electric shock is to be determined by repeating the insulation resistance measurement described in Insulation Resistance Test, Section 27, and the Dielectric Voltage-Withstand Test described in Section 30.

29 Water Temperature Test

29.1 To determine compliance with 23.1, the heater is to be operated as described in 28.2.5, and the temperature of the water at the water outlet is to be measured as water is drawn off immediately following the second opening of the temperature-regulating thermostats.

29.2 To determine compliance with 24.1, the heater is to be tested as follows. After a tank full of water has been heated to the temperature at which the regulating thermostats open, one-fourth of the water is to be drawn off and replaced promptly with cold water. Immediately after the first closure of a regulating thermostat thereafter, the regulating thermostats are to be short-circuited as described in 29.3, and operation is to be continued until the temperature-limiting control opens. Immediately thereafter, hot water is to be drawn off and its temperature is to be measured at the hot water outlet. This procedure usually gives an accurate measurement of the temperature of the water in the upper 25 percent of the tank, and unusual conditions necessitate use of a probe or thermocouple within the tank.

29.3 In accordance with 29.2, the temperature-regulating thermostats are to be short-circuited as follows:

a) When the thermostat directly controls the heating load current:

1) The thermostat is to be short-circuited in a heater incorporating only one thermostat.

2) Two thermostats are to be short-circuited simultaneously in a heater incorporating two or more thermostats. The limiting control is to remain functional and in the circuit; and

b) When the thermostats control the coil of a magnetic contactor, only one thermostat is to be short-circuited at a time, regardless of the total number of temperature-regulating thermostats provided.

30 Dielectric Voltage-Withstand Test

30.1 A water heater shall be subjected to the application of a 60 hertz sinusoidal potential, for 1 minute, between live parts and dead metal parts, with the water heater at the temperature attained in the test described in 28.2.1 – 28.2.9. The test potential is to be 1000 volts for an appliance rated at 250 volts or less, and 1000 volts plus twice the rated voltage for a heater rated at more than 250 volts. The water heater complies with the requirement when there is no dielectric breakdown.

30.2 To determine compliance with 30.1, the heater is to be tested by means of a 500 volt-ampere or larger capacity testing transformer, the output voltage of which varies. Starting at zero, the applied potential is to be increased until the required test value is reached and to be held at that value for 1 minute. The increase in the appliance potential is to be as uniform as possible and as rapid as is consistent with accurate voltmeter indication. During the test, the storage tank is to be full of water and all plumbing connections are to be attached to the water system.

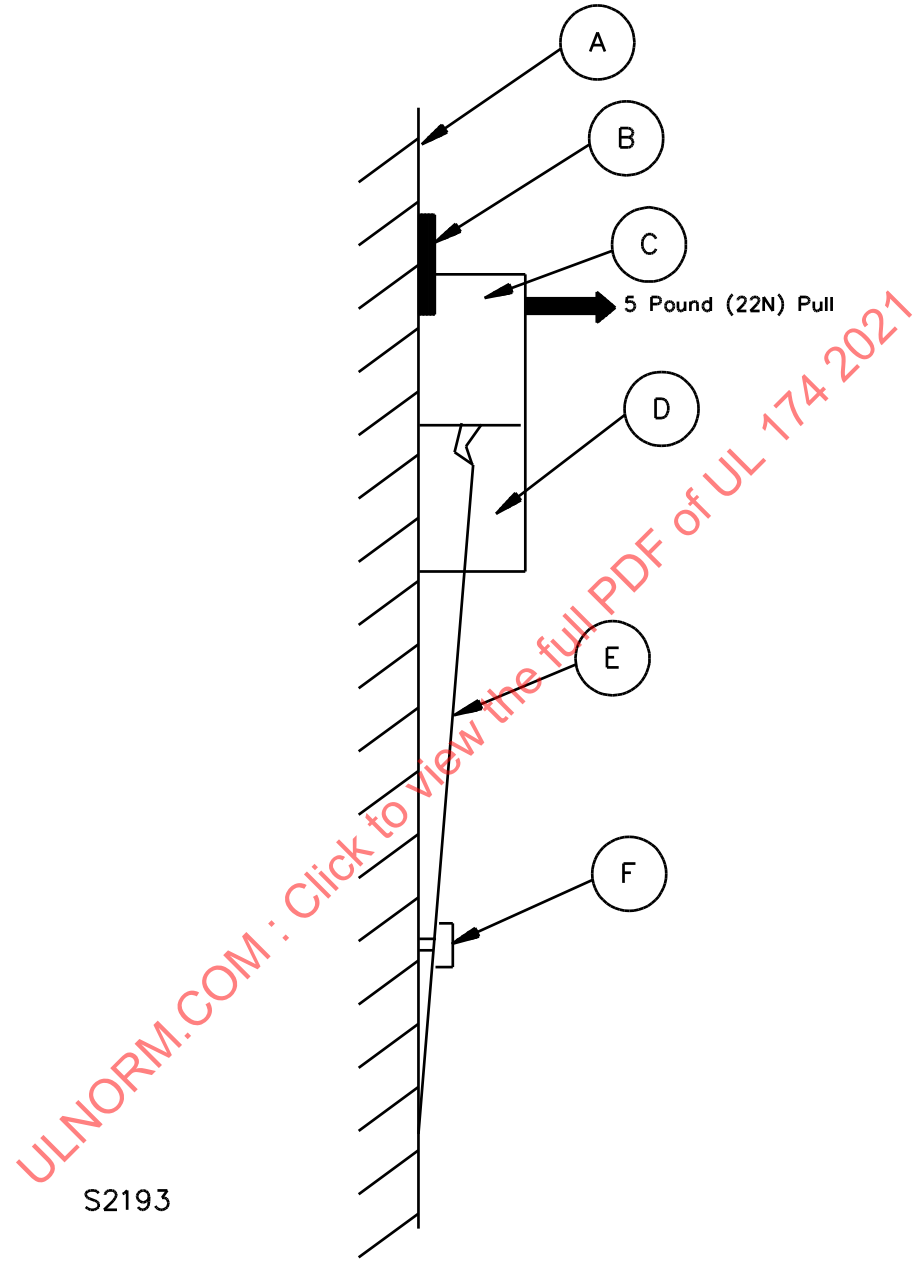
31 Mounting Test of Surface-Mounted Temperature Controls

31.1 Horizontal pull

31.1.1 To determine that a surface-mounted temperature control is securely mounted to the water heater tank as required in 7.2, a direct pull of 5 pounds (22 N) is to be applied to the control at the point which results in the control being displaced from the tank, in a direction perpendicular to the tank surface in contact with the control, as illustrated in Figure 31.1. The pull is to be applied for 5 seconds, and then released. The surface-mounted temperature control meets the requirement when, after the pull has been applied and released, a test strip of metal or plastic 1/64 inch (0.4 mm) thick is not capable of being inserted vertically more than 1/8 inch (3.2 mm) between the intended contact surfaces of the control and the tank. The test strip is to be inserted with a force of 1/2 pound (2.2 N).

Figure 31.1

Example of test of temperature control mounting means



A. Outer surface of storage tank

B. 1/64 inch (0.4 mm) thick metal or plastic test strip applied after the pull has been released

C. Temperature-limiting control

D. Temperature-regulating control

E. Fork-shaped mounting bracket

F. Heating element mounting bolt

31.2 Supply lead pull

31.2.1 To determine compliance with 7.2, the leads of a surface-mounted temperature control shall be subjected to a force of 20 pounds (89 N) applied for 1 minute in a direction that results in the maximum stress on the control that the construction permits. The force is to be applied from the supply wiring compartment. The control complies with the requirement when the control is not dislodged from the mounting means.

Exception: Power-supply-cord connected heaters are not required to be subjected to the supply lead pull test.

32 Barrier Pull Tests

32.1 To determine that a cover or barrier less than 1/16 inch (1.6 mm) thick has equivalent mechanical strength as specified in the Exception of 8.4(b), a direct force of 3 pounds (13.3 N) is to be applied to the barrier or cover at those points that result in displacement of the barrier or cover. The force is to be applied using a metal rod having a flat end surface 1/8 inch (3.2 mm) in diameter. The barrier or cover complies with the requirement when they are not displaced enough to expose uninsulated live parts.

32.2 To determine that a barrier held in place by two independent means complies with 8.4(d), a direct horizontal pull of 3 pounds (13.3 N) is to be applied to the barrier at the point that results in displacement of the barrier. The barrier complies with the requirement when it is not dislodged, and uninsulated live parts are not exposed.

33 Water Capacity Test

33.1 The actual water capacity of a water heater shall be no less than 90 percent of the marked rated capacity.

33.2 Unless the actual capacity of a water tank is known, or is obviously 90 percent or more of the rated capacity, the tank capacity is to be measured by any convenient means.

34 Grounding-Circuit Resistance Measurement Test

34.1 To determine compliance with 14.1.6, any convenient method is to be used to measure grounding-circuit resistance. When high resistance measurements are obtained, a referee test is to be conducted in accordance with 34.2.

34.2 The referee test for grounding-circuit resistance is to be conducted by passing a direct or alternating current equal to the current rating of the maximum current rated branch circuit overload protective device that is employed with the heater (at a potential not to exceed 12 volts) from the equipment grounding terminal or point of attachment of the wiring to a dead metal part. The resulting drop in potential is to be measured between these two points, and the resistance in ohms is to be calculated.

35 Storage Tank Hydrostatic Pressure Test

35.1 To determine compliance with Exception No. 2 or 3 of 25.1, the test sample is to be filled with water to exclude air and is to be connected to a hydraulic pump system. The pressure is to be increased from atmospheric pressure at a rate of 20 ±5 pounds per square inch gauge (psi) (137.9 ±34.5 kPa) per second. When twice the maximum working pressure or 300 psi (2068 kPa) is reached, whichever is greater, that pressure is then to be maintained for 15 minutes.

35.2 For a metal tank, there shall be no leakage of water or visible, permanent distortion of the tank during the test.

35.3 For a polymeric tank, there shall be no leakage of water or permanent distortion of the tank during the test. To determine permanent distortion of a polymeric storage tank, before starting the test in 35.1, circumferential measurements are to be taken at intervals along the storage vessel of not more than 12 inches (305 mm) by readings to be directly to 0.001 inch (0.025 mm). Extensometers reading to 0.001 inch (0.025 mm) shall be placed with the movable spindles against top and bottom heads. After completion of the hydrostatic pressure test in 35.1, the measurements originally taken are to be repeated and circumference measurements shall not vary by more than 0.2 percent of the corresponding measurement taken prior to the application of the test pressure. Top or bottom head deflections as shown by the extensometers shall not exceed 0.5 percent of the tank diameter.

36 Nonmetallic Dip Tube Tests

36.1 Deformation of weight loss

36.1.1 A nonmetallic dip tube when tested in accordance with the requirements of 36.1.2 – 36.1.4 shall:

a) Have a linear deformation not in excess of 1/2 inch (12.7 mm);

b) Have a total lateral deformation not in excess of 1-1/2 inches (38.1 mm); and

c) Undergo no weight loss.

36.1.2 Twelve 51 inch (1.30 m) long samples of each kind and section of dip tubes are to be submitted for these tests. Each sample is to be cut to a length of 49 inches (1.24 m), and the weight of each tube is to be determined by use of a laboratory grade measuring device with a full scale not to exceed 3 times the weight of the sample.

36.1.3 Linear deformation is to be determined by suspending the samples as they are in service for 48 hours in water maintained at 93°C (200°F). These samples are then to be cooled to room temperature, any surface water is to be removed, and the length and weight are to be determined and compared with the original results. Any weight loss is evidence of noncompliance.

36.1.4 Lateral deformation is to be determined by installing one end of each sample in a fixture (as it is by a tank inlet fixture) and measuring the distance between the position of the center line of the free end and the extended center line of the fixture. Following immersion for 48 hours in water maintained at 93°C (200°F), the samples are to be cooled to room temperature, any surface water is to be removed, and the lateral deformation measured. The total lateral deformation of each sample is capable of being used when it is within the limits of a circle having a radius of 1-1/2 inches (38.1 mm) measured from the extended center line of the fixture.

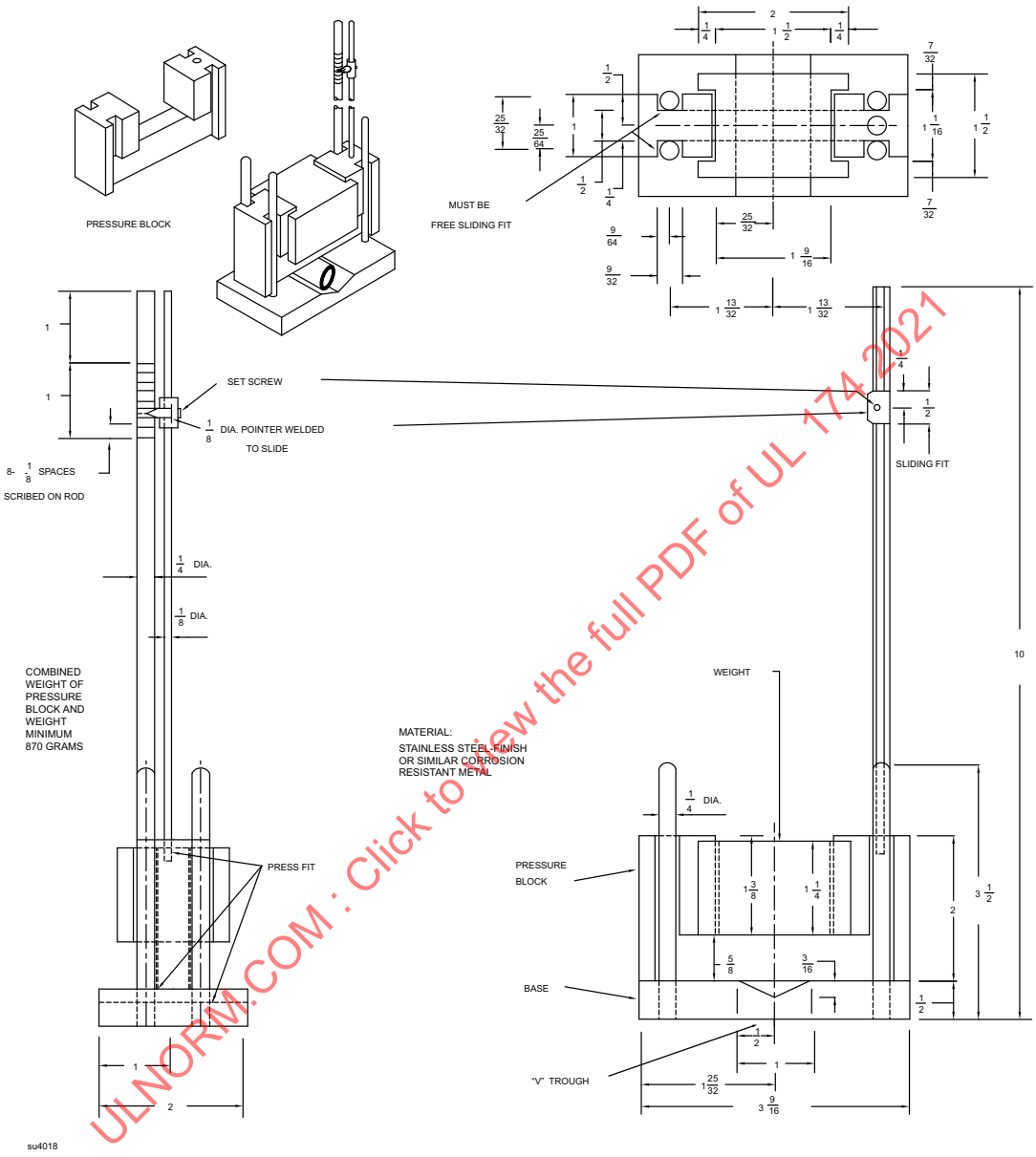
36.2 Resistance to crushing

36.2.1 A nonmetallic dip tube shall not deform more than 1/4 inch (6.4 mm) for a test period of 24 hours when subjected to transverse loading under a weight of 870 grams (31 ounces) while being maintained at a temperature of 107 plus 3 minus 0°C (225 plus 5 minus 0°F) as described in 36.2.2 – 36.2.5.

36.2.2 Ten 2 inch (50.8 mm) long samples of each kind and section of dip tubes are to be subjected to this test. The apparatus for the test is to be as illustrated in Figure 36.1.

Figure 36.1

Heat deformation tester



Note: Dimensions of the pressure block, “V” trough, and the spaces scribed on the rod (i.e. measurement marks) are considered critical and tolerances are ±1/32”. All other dimensions shown are considered approximate.

Inch	(mm)	Inch	(mm)	Inches	(mm)	Inches	(mm)
1/8	(3.2)	9/32	(7.1)	1	(25.4)	1-9/16	(39.7)
9/64	(3.6)	25/64	(9.9)	1-1/16	(27)	1-25/32	(45.2)
3/16	(4.8)	1/2	(12.7)	1-1/4	(31.8)	2	(50.8)
7/32	(5.6)	5/8	(15.9)	1-3/8	(34.9)	3-1/2	(88.9)
1/4	(6.4)	25/32	(19.8)	1-13/32	(35.7)	3-9/16	(90.5)
				1-1/2	(38.1)	10	(254)

36.2.3 The scale on the test apparatus shown in Figure 36.1 is to be set at zero with a sample of the tube to be tested in place in the "V" trough beneath the pressure block. The sample is then to be removed and the test apparatus placed in a 1 liter glass beaker filled with ethylene glycol, glycerin, or a similar liquid to a depth required to cover the pressure block when at the zero scale setting. The glass beaker is then to be placed over a hot plate and heated until the temperature of the liquid and test apparatus, as determined by a thermometer placed in the beaker with its bulb on the base of the test apparatus, has reached 107 plus 3 minus 0°C (225 plus 5 minus 0°F). The temperature is then to be held constant for the duration of the test.

36.2.4 The pressure block is then to be raised and the sample of the dip tube to be tested placed in the "V" trough below the block. The block is then to be lowered without impact onto the dip tube sample and the time recorded. At the end of a 24 hour period the distance of travel of the indicator on the scale is to be recorded, the test sample removed, and the test repeated on the remaining test samples.

36.2.5 The dip tube complies with the requirements when the average deformation of the samples does not exceed 1/4 inch (6.4 mm) and the rate of deformation is uniform. Immediate deformation of any test sample upon application of the test load is to be identified as noncompliance of the lot submitted for test.

36.3 Collapse

36.3.1 A nonmetallic dip tube shall not collapse, as evidenced by a reduction in internal diameter in excess of 1/8 inch (3.2 mm) after immersion in water at a temperature of 107 plus 3 minus 0°C (225 plus 5 minus 0°F) under the conditions of test described in 36.3.2 – 36.3.6. A tank rated for the test pressure is to be used.

36.3.2 The internal diameter of a 49 inch (1.24 m) long sample of each style and kind of dip tube is to be determined before the conditioning described in 36.3.3 – 36.3.6.

36.3.3 The sample is to be installed in the hot water outlet of a typical water heater. A quick acting valve is to be installed at the outlet connection of the storage vessel. The minimum cross-sectional area through this valve is to be equal to or greater than that of an ANSI B36.10, Schedule 40, 1/4 inch pipe having an internal diameter of 0.364 inch (9.25 mm). A flow restricting device adjusted or constructed so as to maintain a flow rate of 5 gallons (18.9 L) per minute during the test period is to be connected to the inlet of the heater.

36.3.4 A mercury thermometer graduated to 0.5°C (1°F) or a thermocouple for connection to a potentiometer is to be installed in the storage vessel within the top 6 inches (152 mm) of the tank. A water pressure regulator is to be located between the inlet connection to the storage vessel and the water supply line and adjusted so that, at a steady flow rate of 5 gallons (18.9 L) per minute, the pressure at the inlet connection is 40 psi (276 kPa).

36.3.5 The storage vessel is to be filled and the test water heater placed in operation, with the thermostat, when provided, bypassed. When the temperature indicated by the thermometer or thermocouple in the top of the storage vessel is 107 plus 3 minus 0°C (225 plus 5 minus 0°F), the quick acting valve is to be opened and water allowed to flow until the outlet water temperature is the same as the inlet water temperature.

36.3.6 The dip tube is then to be removed from the test heater and examined. Any indication of reduction in internal diameter in excess of 1/8 inch (3.2 mm) from the original diameter is to be identified as noncompliance with this requirement.

37 Strain Relief Test

37.1 The strain relief means provided on a power supply cord shall be subjected for 1 minute to a direct pull of 35 pounds force (156 N) applied to the cord as specified in 37.2.

37.2 The connections of the cord within the water heater are to be disconnected. A 35-pound (15.9-kg) weight is to be suspended on the cord such that the strain relief means is stressed from any angle, as determined by the construction of the water heater. The strain relief does not comply when, at the point of disconnection of the conductors, there is movement of the cord to indicate that stress on the connections results.

38 Push Back Relief Test

38.1 To determine compliance with 12.3.2, a product shall be tested in accordance with 38.2 without occurrence of any of the conditions specified in 12.3.2 (a) – (c).

38.2 The supply cord is to be held 1 inch (25.4 mm) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. When a removable bushing, which extends further than 1 inch is present, it is to be removed prior to the test. When the bushing is an integral part of the cord, then the test is to be carried out by holding the bushing. The cord is to be pushed back into the product in 1 inch (25.4 mm) increments until the cord buckles or the force to push the cord into the product exceed 6 pounds-force (26.7 N). The supply cord within the product is to be manipulated to determine compliance with 12.3.2.

39 Electrical Disturbance Test of Foam Thermal Insulation

39.1 In accordance with Exception No. 4 of 21.2.1, an electrical disturbance test shall be conducted to determine that synthetic foam in contact with internal wiring does not result in a risk of fire.

39.2 A fault is to be induced in a wire by peeling or stripping back the wire insulation 1/2 inch (12.7 mm) and removing 80 percent of the strands (for solid conductors, the diameter is to be reduced 80 percent) for a distance of 1/4 inch (6.4 mm). The insulation is then to be replaced over the conductor.

39.3 The prepared wiring is then to be placed in the foam insulation located between the outer metal enclosure and the water tank, and connected to a circuit of rated voltage. An overload current, as indicated in Table 39.1, is then to be made to flow through the circuit.

Table 39.1
Electrical disturbance test conditions

Rating of overcurrent protection, amperes	Value of test current in percent of overcurrent rating		
	110	135	200
	Duration of current flow		
0 – 30	4 – 7 hours	1 hour	2 minutes
31 – 60	4 – 7 hours	1 hour	4 minutes
61 – 100	4 – 7 hours	2 hours	6 minutes

39.4 The circuit is to be energized at the 110 percent value, increased to the 135 percent value, and then raised to 200 percent, all for the times indicated in Table 39.1. The results comply when, after the test has been conducted three times, there is no ignition of the foam insulation as a result of an arc induced by the wiring opening. When at any time during the test, the wiring opens and an arc ignites the foam, the foam does not comply, and the test is to be concluded.

39.5 With regard to the test described in 39.4, when the wiring opens prior to the completion of the test and there is no ignition of the foam insulation, a new sample of wiring is to be prepared as described in 39.2, and the test is to be continued from the point in the test that the wire opened.

39.6 When the wiring does not open within the time limits of the test, the test is to be continued until the wiring opens, or a new sample of wiring is to be prepared with a greater percentage of the strands (or diameter) reduced, and the test repeated.

40 Leakage Current Test

40.1 A cord- and plug-connected water heater shall be tested in accordance with 40.2 – 40.7. The water heater complies when the leakage current does not exceed 0.75 milliampere.

40.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conducted between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of the appliance.

40.3 All exposed conductive surfaces are to be tested for leakage current. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively when simultaneously accessible, and from one such surface to another when simultaneously accessible. A surface is evaluated to be exposed unless protected against inadvertent contact by an enclosure or the equivalent that meets the requirements of Frame, Enclosures, and Outer Jacket, Section 6. Surfaces are simultaneously accessible when they are readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that do not to involve a risk of electric shock.

40.4 When part or all of an enclosure is of material other than metal, a piece of metal foil measuring 100 by 200 mm is to be placed on the enclosure so that all of the foil is in close contact with the surface of the appliance. Leakage current is then to be measured from the foil to the grounded supply conductor, and from the foil to exposed conductive surfaces of the appliance. The foil is not to be left in place long enough to affect the temperature of the appliance.

Exception: For an enclosure surface smaller than 3.94 by 7.87 inches (100 by 200 mm), the piece of metal foil is to be the same size as the surface.

40.5 The measurement circuit for leakage current is to be as shown in Figure 40.1. The defined measurement instrument is as specified in (a) – (d). The meter that is actually used for a measurement is required to indicate the same electrical value for a particular measurement as the defined instrument; it is not required to have all the attributes of the defined instrument.

a) The defined meter has an input impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor.

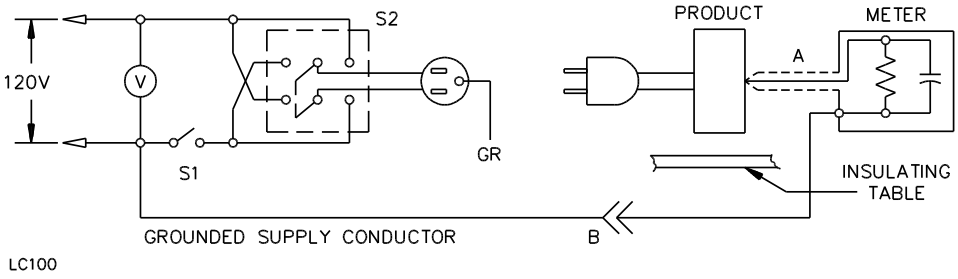
b) The defined meter indicates 1.11 times the average of the full wave rectified composite waveform of the voltage across or current through the resistor.

c) The defined meter, over a frequency range of 0 – 100 kilohertz, has a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to a 1500 ohm resistor. At an indication of 0.75 milliampere, the measurement is to have an error of no more than 5 percent at 60 hertz.

d) Unless the meter is being used to measure leakage from one part of an appliance to another, it is to be connected between the accessible parts and the grounded supply conductor.

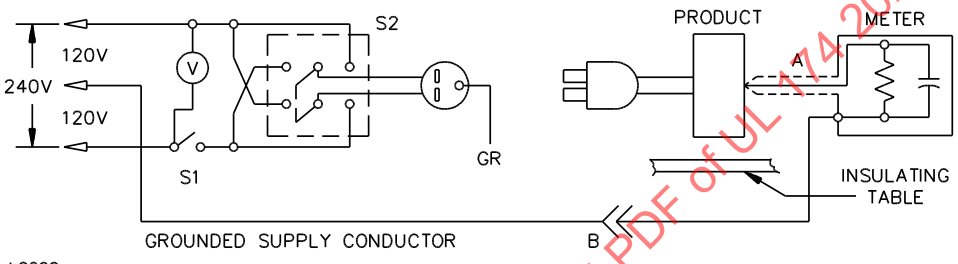
Figure 40.1

Leakage current measurement circuits



LC100

Appliance intended for connection to a 120 volt power supply.



LC200

Appliance intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

NOTES:

A: Probe with shielded lead.

B: Separated and clipped to appliance when measuring currents from one part of appliance to another.

40.6 A sample of the appliance is to be tested for leakage current starting with the as-received condition and with its grounding conductor open at the attachment plug. In the as-received condition, the appliance has not been previously energized except that which occurred during production line testing. The supply voltage sequence with reference to the measurement circuits shown in Figure 40.1 is to be as follows:

a) With switch S1 open, the appliance is to be connected to the measurement circuit, and the leakage current is to be measured using both positions of switch S2 with the appliance switching device in all intended operating positions.

b) Switch S1 is then to be closed, energizing the appliance, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2 with the appliance switching device in all intended positions.

c) The leakage current is to be monitored until thermal stabilization has been attained. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation of the appliance as in the temperature test.

40.7 A sample is to be carried through the complete leakage current test program without interruption for other tests. However, with the concurrence of all concerned, the leakage current test is to be interrupted for the purpose of conducting other nondestructive testing.

41 Enclosure Strength Test

41.1 In accordance with Exceptions of 6.2.1 and 6.3.1, a water heater with an enclosure or outer jacket thinner than specified in Table 6.1 and Table 6.2 shall be subjected to a static load of 50 pounds-force (222.5 N) as described in 41.2. The water heater complies when, during or after the application of the force, there is no reduction of electrical spacings below the minimum values specified in Section 13, Electrical Spacings, and no live parts are made accessible to contact as specified in Section 8, Accessibility of Live Parts.

41.2 As required by 41.1, the enclosure or outer jacket shall withstand a force of 50 pounds (222.5 N). The force is to be applied by means of a 1/2 inch (12.7 mm) diameter metal rod with a rounded end shaped to a 1/4 inch (6.4 mm) radius hemisphere. The rounded end of the metal rod is to be in contact with the enclosure and a force of 50 pounds (222.5 N) is to be applied in a direction parallel to the longitudinal axis of the rod. The enclosure is to be tested on all surfaces thinner than specified in Table 6.1 and Table 6.2.

42 Permanence of Markings

42.1 The markings required in Sections 46 – 49 shall be located on the enclosure or on a part that either requires a tool for removal or, when removed, impairs operation of the appliance. In addition, a marking that is required to be permanent shall be:

a) Etched;

b) Molded;

c) Die stamped;

d) Paint stenciled;

e) Permanently secured, stamped or etched metal; or

f) Indelibly stamped lettering on pressure sensitive labels secured by adhesive.

Pressure sensitive labels secured by adhesive shall comply with the requirements in the Standard for Marking and Labeling Systems, UL 969. Usage, in handling, or storage of the appliance is evaluated in determination of permanence of marking.

MANUFACTURING AND PRODUCTION TEST

43 Production Line Dielectric Voltage-Withstand Test

43.1 As a routine production line test, each appliance shall be subjected to the application of a potential at a frequency within the range of 40 – 70 hertz:

a) Between the primary wiring, including connected components, and accessible dead metal parts that become energized; and

b) Between primary wiring and accessible low voltage (42.4 volts peak or less) metal parts, including terminals.

The appliance complies with the requirement when there is no dielectric breakdown.

43.2 The production line test shall be in accordance with either Condition A or Condition B of Table 43.1.

Table 43.1
Production line test conditions

Appliance rating,	Condition A		Condition B	
volts	volts	seconds	volts	seconds
250 or less	1200	1	1000	60
More than 250	1200 + 2.4V[a]	1	1000 + 2V[a]	60
[a] V is the maximum marked voltage, and no less than 240 volts.				

43.3 The appliance is to be in a heated or unheated condition for the test.

43.4 The test is to be conducted when the appliance is fully assembled. It is not intended that the appliance be unwired, modified, or disassembled for the test.

Exception No. 1: A part such as a snap cover or friction fit knob that interferes with conducting the test is not required to be in place.

Exception No. 2: When requested, the test is to be performed before final assembly when the test represents that for the complete appliance.

43.5 When the appliance employs a solid state component that is not relied upon to reduce the risk of electric shock and that is damaged by the dielectric potential, the test shall not be conducted before the component is electrically connected, unless a random sampling of each day's production is tested at the potential specified in Table 43.1. The circuitry is rearranged for the purpose of the test to reduce the risk of solid state component damage while retaining the representative dielectric stress of the circuit.

43.6 The investigation of thermal insulation specified in 21.1.2 is not required to be conducted when each water heater is subjected to a routine production line Dielectric Voltage-Withstand Test in accordance with Section 30. Test potentials are to be applied for 1 second, and are to be 1500 volts for a heater rated 250 volts or less and 2500 volts for a heater rated more than 250 volts.

43.7 The test equipment is to include a transformer having sinusoidal output, a means of indicating the test potential, an audible or visible indicator of dielectric breakdown, and either a manual reset device to restore the equipment after dielectric breakdown or an automatic reject feature activated by a unit not capable of being used.

43.8 When the rated output of the test equipment transformer is less than 500 volt-amperes, the equipment is to include a voltmeter in the output circuit to directly indicate the test potential.

43.9 When the rated output of the test equipment transformer is 500 volt-amperes or larger, the test potential is to be indicated:

a) By a voltmeter in the primary circuit or in a tertiary winding circuit;

b) By a selector switch marked to indicate the test potential; or

c) In the case of equipment having a single test potential output, by a marking in a readily visible location to indicate the test potential.

When a marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manual reset switch has been reset following a dielectric breakdown.

43.10 Test equipment other than that described in 43.7 – 43.9 shall not be used unless found to accomplish the intended factory control.

43.11 During the test, one or both sides of the primary circuit of the appliance are to be connected to one terminal of the test equipment, and the second test equipment terminal is to be connected to the accessible dead metal.

Exception No. 1: As an alternative to 43.11, an appliance (resistive or high impedance winding) having circuitry not subject to excessive secondary voltage build-up in case of dielectric breakdown during the test is to be tested:

a) With a single pole primary switch, when used, in the off position; or

b) With only one side of the primary circuit connected to the test equipment when the primary switch is in the on position or when a primary switch is not used.

Exception No. 2: The primary switch is not required to be in the on position when the testing means applies full test potential between primary wiring and dead metal parts with the switch not in the on position.

RATINGS

44 Electrical

44.1 A water heater shall be rated in amperes or watts, and also in volts, and shall be rated for either alternating current only or direct current only. The ratings shall include the number of phases when the water heater is designed for use on a poly-phase circuit, and shall include the frequency when frequency sensitive components such as relay coils or other control devices require a certain frequency.

44.2 The rated voltage of a water heater having a marked voltage range (such as 110 – 120 volts) is to be evaluated as the maximum voltage of the range.

45 Tank Pressure and Capacity

45.1 A storage tank shall be rated with its maximum working pressure in pounds per square inch or kilopascals, or both. The maximum working pressure shall be no more than 50 percent of the hydrostatic test pressure specified in 25.1.

45.2 The total tank capacity of a water heater shall be indicated in gallons, liters, or both.

MARKINGS

46 Identification

46.1 A water heater shall be legibly and permanently marked, where readily visible after installation, with the following:

a) The manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product is identified;

b) The date or other dating period of manufacture not exceeding any three consecutive months, which is abbreviated or in a nationally accepted conventional code, or a code affirmed by the manufacturer;

c) A distinctive catalog or model number or the equivalent; and

d) The electrical rating.

46.2 The repetition time cycle of the date code specified in 46.1 shall be no less than 26 years. The date code shall not require reference to the manufacturer's records to determine when the water heater was manufactured.

46.3 When a manufacturer produces water heaters of the same model or catalog number at more than one factory, each heater shall bear a marking (or a code) that identifies it as the product of the particular factory.

46.4 The following shall be permanently marked with the manufacturer's name or trademark, an identifying symbol, the lot number, and the listing mark of the agency described in 17.1.1:

a) A nonmetallic dip tube;

b) A nonmetallic heat trap tube; or

c) A nonmetallic inlet water deflector.

46.5 Adhesive attached labels for use as nameplates and/or markings shall comply with the Standard for Marking and Labeling Systems,UL 969, for their intended use.

47 Ratings

47.1 A water heater shall be permanently marked where readily visible with its electrical ratings, and when two or more heating elements are used, with the maximum wattage or current consumption of each element. A heater intended for use on alternating current only or on a specific frequency or frequencies, or on direct current only shall be so marked.

47.2 A two wire heater intended for use only on a 3-wire, 125/250 volt system shall be marked "250 volt, 2 wire, for use only on 125/250 volt, 3 wire system."

47.3 When a water heater having two or more factory-installed heating elements is designed for the operation of only one element at any time, and is factory connected so that only one element operates at a time, the "maximum wattage or current consumption" specified in 47.1 is to be evaluated as that of the single element having the highest input rating.

47.4 When replaceable in the field, a heating element rated at more than 1 ampere shall be plainly and permanently marked with one or both of the following:

a) Its electrical ratings in amperes or watts, and volts; or

b) The manufacturer's part number.

47.5 The maximum working pressure and the total water capacity of a heater, as described in 45.1 and 45.2, for the storage tank that operates at other than atmospheric pressure and, when applicable, the ASME Code symbol specified in 25.1, shall be plainly and permanently marked on the exterior of the water heater. When a tank is marked with an ASME Code symbol, the maximum working pressure marked on the exterior of the water heater shall not exceed the maximum working pressure marked on the tank.

47.6 A water heater rated more than 16.0 and less than 16.7 amperes shall be marked where readily visible during installation with the following or the equivalent: "For connection to a maximum _____ ampere overcurrent protected branch circuit". The blank is to be filled in with either 25 or 30.

47.7 A marking on, or in addition to, the nameplate shall be provided on a cord-connected unit if that unit has a marked ampere rating which exceeds 50 percent of the rating of the branch circuit to which it may be connected in accordance with ANSI/NFPA 70. The marking shall be permanent, in letters not less than 4.8 mm (3/16 inch) high located adjacent to the cord entrance of the product enclosure. This marking shall read: “Use on Single Outlet Circuit Only.”

Exception: The marking on a unit with a 15 ampere attachment plug may read: “Use on 15 Ampere Single Outlet Circuit or shared 20 Ampere circuit,” if the marked rating of the unit does not exceed 10 amperes.

48 Warning Notices

48.1 When the temperature-limiting control must be replaced after it has performed its intended function, the water heater shall be permanently marked with the word "DANGER" and the following or the equivalent: "To reduce the risk of electric shock disconnect from power supply before replacing temperature-limiting device". The danger marking shall be located so as to be visible before or immediately upon removal of the cover over the compartment enclosing the temperature-limiting device. The marking shall not be on the back of a removable cover.

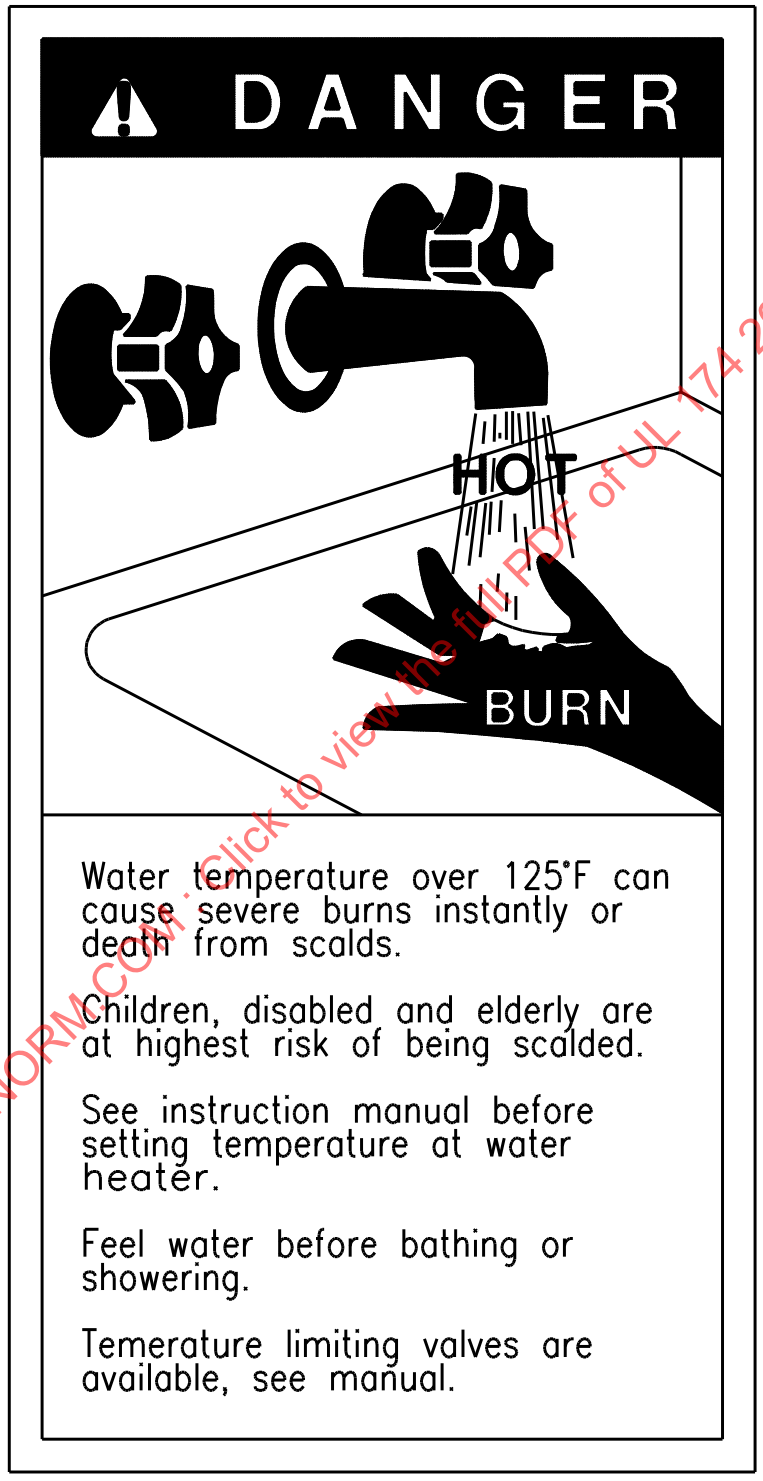
48.2 The words "CAUTION" and "DANGER" shall be in letters no less than 3/32 inch (2.4 mm) high where the words are required in the markings described in Warning Notices, Section 48.

48.3 Unless all components in a water heater are rated for voltages up to 250 volts to ground, the water heater shall be permanently marked with the word "CAUTION" and the following or the equivalent: "To reduce the risk of electric shock or fire use only on a utility supply having a maximum 125/250 volt, three wire system".

48.4 A water heater provided with an adjustable temperature-regulating control shall be provided with a marking as shown in Figure 48.1.

Figure 48.1

Example of scald or burn marking for a water heater with an adjustable temperature-regulating control



48.5 For water heaters 20 gallons (75.7 L) and above, the physical specifications of the label shown in Figure 48.1 shall be as follows:

a) The text of the label shall be located below (vertical arrangement) or to the right of (horizontal arrangement) the graphic illustration. The minimum label sizes are as follows:

i) Vertical: 3 1/4 inches x 6 1/4 inches (82.6 mm x 158 mm); and

ii) Horizontal: 6 inches x 3 1/4 inches (152 mm x 82.6 mm).

b) The label shall be boxed by a 1/4 inch (6.4 mm) border. A 3/8 inch (9.8 mm) red bar shall be at the top of the label, within the border. A red on white international symbol for caution shall be located on the red bar followed by the word "DANGER" in white boldfaced letters having a minimum letter height of 0.240 inches (6.4 mm).

c) The graphic illustrations for the faucet, knobs, bathtub outline, spraying water, and hand shall be black on a white background. The water spattered on the hand shall be in red.

d) The word "HOT" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.180 inches (4.6 mm).

e) The word "BURN" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.140 inches (3.56 mm).

f) All text below the illustration shall be either black boldfaced letters on white background or white boldfaced letters on black background. The letters shall have a minimum uppercase letter height of 0.120 inches (3.05 mm). Lowercase letters shall be compatible with the uppercase letter size specifications.

48.6 For water heaters less than 20 gallons (75.7 L), the physical specifications of the label shown in Figure 48.1 shall be as follows:

a) The text of the label shall be located below the graphic illustration. The minimum label size shall be vertical: 2 1/8 inches x 4 1/8 inches (54 mm x 105 mm).

b) The label shall be boxed by a 1/8 inch (3.2 mm) border. A 1/4 inch (6.4 mm) red bar shall be at the top of the label, within the border. A red on white international symbol for caution shall be located on the red bar followed by the word "DANGER" in white boldfaced letters having a minimum letter height of 0.140 inches (3.56 mm).

c) The graphic illustrations for the faucet, knobs, bathtub outline, spraying water and hand shall be black on a white background. The water spattered on the hand shall be in red.

d) The word "HOT" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.120 inches (3.05 mm).

e) The word "BURN" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.120 inches (3.05 mm).

f) All text below the illustration shall be either black boldfaced letters on white background or white boldfaced letters on black background. The letters shall have a minimum uppercase letter height of 0.070 inches (1.78 mm). Lowercase letters shall be compatible with the uppercase letter size specifications.

48.7 When the marking specified in 48.4 is printed on adhesive-backed label material, it shall comply with applicable requirements in the Standard for Marking and Labeling Systems, UL 969.

48.8 A water heater shall be permanently marked adjacent to the outside of the wiring compartment cover with the word "CAUTION", and the following or the equivalent: "Risk of Electric Shock. Connect branch circuit equipment grounding means to water heater. For detailed information, refer to instructions".

48.9 A cord- and plug-connected water heater shall be plainly and permanently marked with the word "CAUTION " and the following or the equivalent: "Risk of Electric Shock and Fire Hazard. Do not connect to supply by extension cord".

48.10 A cord- and plug-connected water heater shall be plainly and permanently marked with the word "CAUTION " and the following or the equivalent: A damaged power supply cord must be replaced with one supplied by the unit manufacturer and not repaired.

49 Informational Markings

49.1 A water heater shall be plainly and permanently marked with the following statement: "Install temperature and pressure protective equipment required by local codes, but no less than a combination temperature and pressure relief valve certified as meeting the requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22, by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials. The valve must be oriented, provided with tubing, or otherwise installed so that discharge can exit only within 6 inches above, or at any distance below, the structural floor, and cannot contact any live electrical part".

49.2 The hot water outlet shall be plainly marked so that it is easily identified. The cold water inlet shall be plainly marked unless it is located near the bottom of the tank.

49.3 When a multi-element water heater is intended to be connected to more than one power supply circuit (for example, a heater in which one or more elements are intended to be connected through a clock operated switch or a demand meter), the terminals or leads for each circuit shall be plainly and positively identified by a permanent marking adjacent to the terminals or leads themselves or by means of a wiring diagram.

49.4 A water heater incorporating a nonmetallic dip or heat trap tube shall bear a tag attached to, or a label adjacent to, the cold water inlet or hot water outlet, as appropriate, marked with the following or the equivalent: "Do not apply heat to this fitting while making sweat connections to heater. Sweat tubing to adapter before fitting adapter to heater. It is imperative that no heat be applied to this fitting, as it is connected to a nonmetallic dip (or heat trap) tube".

49.5 In accordance with 11.3.5, field-wiring terminals of a heater shall be marked with the following or the equivalent: "Use copper conductors only" or "For use with aluminum or copper conductors". This marking shall be adjacent to the terminal or located on or adjacent to the marking required in 46.1, and shall be independent of any other marking on terminal connectors. The marking shall be visible during and after installation of the heater.

49.6 A water heater shall be provided with a wiring diagram that is readily available for service personnel.

49.7 When required overcurrent protective devices are provided as a separate assembly in accordance with 16.2, the water heater shall be permanently marked to indicate that it is to be used only with this separate assembly. For example: "This water heater is to be used only with (manufacturer's identification) Model (or Catalog) _____ overcurrent protection assembly".

49.8 The separate overcurrent assembly shall be permanently marked, where readily visible after installation, with the name or identifying symbol of the manufacturer, the model or catalog number, and the electrical rating.

49.9 A water heater shall be marked "when a supplemental heat source is connected to the Certified Household Electric Storage Tank Water Heater, provision must be made to limit the heat source temperature not to exceed that of the water heater thermostat setting". (An example of supplemental heat is a refrigeration loop off of the condensing unit of an air conditioning system).

49.10 A water heater shall be marked "Caution: If the water heater has been retrofitted with supplemental heating equipment, you must adjust both the thermostat controlling the supplemental heat source (located in the water piping) and the thermostat on the water heater (behind the access panel) to the same temperature. Failure to adjust both thermostats to the same temperature can cause loss of proper temperature control".

INSTRUCTIONS

50 General

50.1 A water heater shall be provided with installation instructions that include the word "CAUTION" and the following or the equivalent: "To reduce the risk of excessive pressures and temperatures in this water heater, install temperature and pressure protective equipment required by local codes and no less than a combination temperature and pressure relief valve certified by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, as meeting the requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22. This valve must be marked with a maximum set pressure not to exceed the marked maximum working pressure of the water heater. Install the valve into an opening provided and marked for this purpose in the water heater, and orient it or provide tubing so that any discharge from the valve exits only within 6 inches above, or at any distance below, the structural floor, and does not contact any live electrical part. The discharge opening must not be blocked or reduced in size under any circumstances ".

50.2 A water heater equipped with an adjustable temperature-regulating control shall be provided with instructions that:

a) Inform the user that the thermostat or thermostatic mixing valve, as applicable, has been set at the factory to 51.7°C (125°F) or lower, see 23.3 – 23.4, to reduce the risk of scald injury;

b) Inform the user how to change this setting when the user so desires;

c) Include any precautions to be followed in changing the setting; and

d) Provide information regarding the availability of temperature-limiting valves for use in hot water lines.

50.3 A water heater equipped with a cathodic protection device or a sacrificial anode shall be provided with instructions that include the word "CAUTION" and the following or equivalent: "Hydrogen gas is produced in a hot water system served by this heater that has not been used for a long period of time (2 weeks or more). Hydrogen gas is extremely flammable. To reduce the risk of injury under these conditions, it is recommended that the hot water faucet be opened for several minutes at the kitchen sink before using any electrical appliance connected to the hot water system. When hydrogen is present, there will probably be an unusual sound such as air escaping through the pipe as the water begins to flow. There should be no smoking or open flame near the faucet at the time it is open".

50.4 The instructions shall include detailed information on the method of grounding the water heater for both metallic and nonmetallic wiring systems.

50.5 The instructions shall specify that when a water heater is installed in a closed water-supply system, such as one having a back-flow preventer in the cold-water supply, means shall be provided to control

thermal expansion. Contact the water supplier or local plumbing inspector for information regarding the control of this situation.

51 Safety Instructions

51.1 A cord- and plug-connected water heater shall be provided with the Important Safety Instructions specified in 51.1 – 51.5.

51.2 All instructions contained in the user manual, where specific wording is indicated, shall be legible and shall contrast with the background. Upper case letters shall be no less than 5/64 inch (2 mm) high, and lower case letters shall be no less than 1/16 inch (1.6 mm) high. Headings such as "IMPORTANT SAFETY INSTRUCTIONS" or "SAVE THESE INSTRUCTIONS", shall be in letters no less than 3/16 inch (4.8 mm) high.

51.3 The instructions described in 51.5 shall be located before, and shall be separate in format from, other detailed instructions related to operation, assembly, and maintenance of the appliance. All instructions shall be a permanent part of the manual.

51.4 Unless otherwise indicated, the instructions described in 51.5 shall be in the exact words specified or shall be in equally definitive terminology.

51.5 The statement "IMPORTANT SAFETY INSTRUCTIONS" or the equivalent shall precede the list, and the statement "SAVE THESE INSTRUCTIONS" or the equivalent shall either precede or follow the list. The word "WARNING" shall be entirely in upper case letters or shall be emphasized to distinguish it from the remainder of the text.

IMPORTANT SAFETY INSTRUCTIONS

WARNING – When using electrical appliances, basic safety precautions to reduce the risk of fire, electric shock, or injury to persons should be followed, including:

1. READ ALL INSTRUCTIONS BEFORE USING THIS WATER HEATER.

2.This water heater must be grounded. Connect only to properly grounded outlet. See "GROUNDING INSTRUCTIONS" found on (specific page or section to be included).

3. Install or locate this water heater only in accordance with the provided installation instructions.

4. Use this water heater only for its intended use as described in this manual.

5. Do not use an extension cord set with this water heater. If no receptacle is available adjacent to the water heater, contact a qualified electrician to have one properly installed.

6. As with any appliance, close supervision is necessary when used by children.

7. Do not operate this water heater if it has a damaged cord or plug, if it is not working properly, or if it has been damaged or dropped.

8. This water heater should be serviced only by qualified service personnel. Contact nearest authorized service facility for examination, repair, or adjustment.

9. Do not use multi-outlet adaptors (i.e. power strips) with this water heater.

SAVE THESE INSTRUCTIONS

OUTDOOR-USE EQUIPMENT

52 General

52.1 An outdoor-use water heater shall comply with applicable requirements of the preceding Sections of this Standard and shall, in addition, comply with the following requirements.

53 Enclosures

53.1 An enclosure or enclosures shall be so constructed as to reduce the likelihood of the wetting of live parts as indicated below and protect the system against electric shock due to weather exposure.

53.2 To determine compliance with this requirement, a complete assembly, with supply conduit connections and without pipe thread compounds, is to be subjected to the Rain Test. See 56.1.

53.3 A water absorbing insulating material shall not become wetted by rain when installed as intended if such wetting will depreciate its durability or insulating value.

53.4 Any panel or cover in the outer enclosure shall require the use of tools to open; unless it can be determined that removal or opening of the panel or cover will not result in a risk of electric shock due to weather exposure or an injury to persons due to moving parts. Hinges and other attachments shall be resistant to corrosion.

53.5 Access doors or panels shall be constructed so that with the doors or panels in place, no water will accumulate within the enclosure during the conduct of the Rain Test. See 56.1.

53.6 Enclosures for electrical components shall have provision for drainage if knockouts or unthreaded openings in the enclosure are employed.

53.7 Cabinets and enclosures shall have a thickness of not less than 0.032 inch (0.81 mm) (No. 20 MSG) if uncoated sheet steel, not less than 0.034 inch (0.86 mm) (No. 20 GSG) if zinc coated sheet steel and not less than 0.029 inch (0.74 mm) (20 AWG) if copper, brass, or aluminum; except as stated in 53.8.

53.8 Enclosures less than 0.032 inch (0.81 mm) No. 20 MSG which correspond with Table 6.1 or Table 6.2 whichever applies, comply with the intent of this requirement if they are protected by an outer cabinet.

53.9 Metal shall not be used in combinations such as to cause galvanic action which will adversely affect cabinets or enclosures.

53.10 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion by the following means or by other metallic or nonmetallic coatings which have been shown to give equivalent protection.

53.11 If the enclosure is of 0.032 inch (No. 16 MSG) (1.6 mm) or heavier and it is not the sole enclosure of current carrying parts, it is to be protected by a coating at least equal to one of the following:

a) Hot dipped mill galvanized sheet steel conforming with the coating Designation G60 or A60 in the Weight (Mass) of Coating Requirements table in theStandard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Specification. The weight of zinc coating may be determined by any suitable method; however, in case of question the weight of coating shall be established in accordance with the Test Method of ASTM A90. An A60 (Alloyed) coating shall also comply with 53.14.

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 Chromic Acid Dropping Test. See Chromic Acid Dropping Test in the Standard for Commercial-Industrial Gas Heating Equipment, UL 795. An annealed coating shall also comply with 53.14.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The suitability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.

53.12 If the enclosure is the sole enclosure of current carrying parts or if it is lighter than 0.032 inch (No. 16 MSG) (1.6 mm), it is to be protected by a coating at least equal to one of the following:

a) Hot dipped mill galvanized sheet steel conforming with the coating Designation G90 in of the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirements in this ASTM Specification. The weight of zinc coating may be determined by any suitable method; however, in case of question the weight of 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 Chromic Acid Dropping Test. See Chromic Acid Dropping Test in the Standard for Commercial-Industrial Gas Heating Equipment, UL 795. An annealed coating shall also comply with 53.14.

c) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established in accordance with the Chromic Acid Dropping Test.

d) A zinc coating conforming with 53.11 (a) or (b) with one coat of outdoor paint as specified in 53.11(c).

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0005 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the Chromic Acid Dropping Test and the paint shall be as specified in 53.11(c).

53.13 With reference to 53.9, other finishes, including paints, special metallic finishes and combinations of the two comply with this requirement when comparative tests with galvanized sheet steel, without annealing, wiping or other surface treatment, conforming with 53.11(a) or 53.12, 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.

53.14 A hot dipped mill galvanized A60 (alloyed) coating or an annealed zinc coating which is bent or similarly formed after annealing shall be additionally painted in the bent or formed area if the bending or forming process damages the zinc coating, except that such areas on the inside surface of a cabinet or enclosure which water does not enter during the Rain Test need not be painted.

53.15 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 to be damaged. Simple sheared or cut edges

and punched holes are not considered to be formed, but extruded and rolled edges and holes shall conform with 53.14.

53.16 Nonferrous cabinets and enclosures may be employed without special corrosion protection. The thickness of the material is to be judged on the basis of its strength and rigidity.

53.17 Gaskets required to seal enclosures of electrical components shall comply with the requirements of Accelerated Aging Tests – Gaskets, 56.2.

53.18 All required markings per Sections 46 – 49 located on the exterior of the water heater shall comply with 42.1 and be of the type suitable for outdoor use.

53.19 Water heaters intended to be used outdoors that meet all of the applicable requirements shall include the marking “OUTDOOR USE” or equivalent. The marking shall be legibly and permanently marked and shall be readily visible after installation.

54 Field Wiring Connections

54.1 Openings provided for field wiring connections shall be suitable for connection of conduit. The openings shall be threaded; unless:

a) They are located wholly below the lowest uninsulated live part within the enclosure; or

b) The location prevents drainage into the enclosure.

Threaded holes for conduit shall be reinforced to provide metal at least 1/4 inch (6.4 mm) in thickness; and shall be provided with a conduit end stop unless the thread is tapered.

55 Wiring

55.1 The internal wiring shall be so constructed and assembled as to provide protection against a risk of electric shock due to weather exposure.

Note: For outdoor use equipment, a risk of electric shock is considered to exist in any accessible part of a circuit if a potential greater than the following exists: 15 V rms, 21.2 Vac peak, or 30 V continuous dc.

55.2 The use of moisture resistant wiring material, such as Type RH, RHW, TW, THW, THWN, TFN, or TFFN enclosed in rigid or flexible steel conduit or electrical metallic tubing, or moisture resistant nonmetallic sheathed cable for the wiring between electrical component enclosures complies with the intent of this requirement. Wiring materials of the type indicated in Section 19, installed in either rigid conduit or electrical metallic tubing with raintight fittings or in liquid-tight flexible steel conduit with suitable fittings also comply. Bushings, where used, are to be non-absorptive.

55.3 The wiring assembly shall be so constructed and located as to exclude water from electrical enclosures.

55.4 All wires and cords shall be routed and supported so that they will not be immersed in water.

56 Outdoor-Use Equipment Tests

56.1 Rain test

56.1.1 The rain test apparatus shall consist of three spray heads mounted in a water supply rack as shown in Figure 56.1. The spray heads shall be constructed in accordance with Figure 56.2. The product