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UL 174

STANDARD for SAFETY

HOUSEHOLD ELECTRIC STORAGE TANK WATER HEATERS

UNDERWRITERS LABORATORIES INC.®

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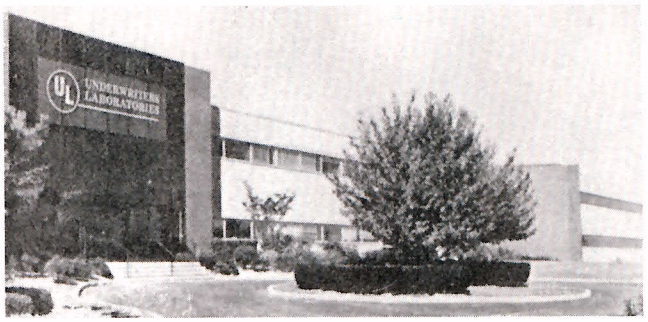

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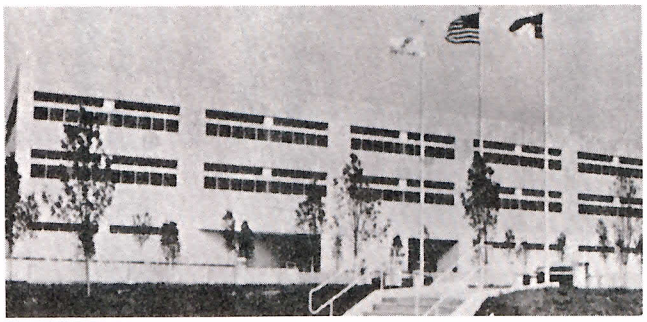

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STANDARD FOR

HOUSEHOLD ELECTRIC STORAGE TANK WATER HEATERS

UL 174, EIGHTH EDITION

Accompanying this transmittal notice is a copy of the eighth edition of UL 174.

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UL 174

STANDARD FOR

HOUSEHOLD ELECTRIC STORAGE TANK WATER HEATERS

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EIGHTH EDITION

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Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages. Information concerning the latest dates of issuance of these pages is available from Underwriters Laboratories Inc. by calling 708-272-8800 (Ext 2234).

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

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.

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 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. General

Components

2.1 A component of a product covered by this standard shall comply with the requirements for that component, and shall be used in accordance with its recognized rating and other limitations of use. See Appendix A for a list of standards covering components generally used in the products covered by this standard. A component need not comply with a specific requirement that:

A. Involves a feature or characteristics not needed in the application of the component in the product covered by this standard, or

B. Is superseded by a requirement in this standard.

Units of Measurement

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

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

References

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

3. Glossary

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

3.2 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.

3.3 HEAT TRAP — A device that can be integrally assembled or independently attached to the hot water connection of a water heater such that a portion of this device will develop a cold water seal to reduce the natural convection and resultant heat loss from the hot water stored in the water heater.

3.4 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 reduce turbulence and aid in mixing of the hot and cold water.

3.5 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).

CONSTRUCTION

4. Frame and Enclosure

General

4.1 The frame and enclosure of a water heater shall have the strength and rigidity necessary to resist the abuses likely to be 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.

4.2 A metal enclosure that encloses or protects a live electrical part shall have a minimum thickness as indicated in Table 4.1 or 4.2.

Magnesium and Nonmetallic Materials

4.3 Among the factors to be taken into consideration in determining if a material other than a polymeric material may be used are (1) mechanical strength, (2) resistance to impact, (3) moisture absorptive properties, (4) combustibility, and (5) resistance to distortion at temperatures to which the material may be subjected under conditions of intended or abnormal use.

4.4 Polymeric materials used in a fixed water heater shall comply with the requirements for fixed equipment in the Standard for Polymeric Materials — Use in Electrical Equipment Evaluations, UL 746C. Polymeric materials used in a stationary water heater shall comply with the requirements for stationary equipment in UL 746C.

TABLE 4.1
MINIMUM ACCEPTABLE THICKNESS OF SHEET-METAL ENCLOSURES

	Sheet Steel				Sheet Aluminum	
	Uncoated		Galvanized			
	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

(TM-372)

TABLE 4.2
MINIMUM ACCEPTABLE 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

(TM-373)

5. Mechanical Assembly

5.1 An electrical component shall be securely mounted in place.

5.2 A surface-mounted temperature control shall be (1) 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 29, or (2) secured directly to the storage tank by positive fastening means such as screws or stud and nut.

6. Accessibility of Live Parts

6.1 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.

6.2 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 if the unit is marked as indicated in paragraph 44.1.

6.3 If 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 is acceptable if a 1/16 inch (1.6 mm) diameter rod cannot contact any uninsulated live part when inserted through such an opening.

6.4 A barrier provided to reduce the risk of contact with a live part as required in paragraph 6.2 shall comply with all the following items. Thermal insulation is not acceptable 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 may be less than 1/16 inch thick, but no less than 1/32 inch (0.8 mm) thick, if ribs or other means of providing mechanical strength, equivalent to a 1/16 inch thick barrier, are provided as determined by paragraph 30.1.

C. Extend at least 1/16 inch beyond any uninsulated live part (including any uninsulated portion of the conductor).

D. Be secured in place by at least two independent means that have been subjected to the barrier pull test described in paragraph 30.2. Two parallel or symmetrical tabs are to be considered as two independent means of securement if they project from two different points on the barrier.

6.5 If a cover or barrier is provided to comply with paragraph 6.2, 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.

7. Wetting of Live Parts

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

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

8. Corrosion Resistance

General

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

Exception: If the oxidation of steel is not likely to be 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 may not be required to be corrosion resistant.

Storage Tanks

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

Exception: A storage tank that carries the American Society of Mechanical Engineers (ASME) Code symbols described in Section 23 need not comply with this requirement.

9. Electrical Supply Connections — Permanent Connection

General

9.1 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.

9.2 A water heater shall have provision for the connection to a permanent wiring system in accordance with paragraph 9.9. 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: A small capacity storage tank water heater may be connected as described in Section 10.

Field-Wiring Compartment

9.3 A heater shall be provided with a metal compartment for connection to the supply (branch circuit) wiring. The volume of the compartment shall be no less than as indicated in Table 9.1. Each conductor extending outside the compartment and terminating inside the compartment is counted as one conductor. The thickness of the metal used for such a compartment shall be as indicated in Table 4.1 or 4.2.

TABLE 9.1
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 No. 4 AWG (21.2 mm^2) or larger conductors, the minimum wire-bending space in Table 9.2 shall be provided.

(TM-374)

9.4 The depth of the compartment in the vicinity of any opening at which supply conductors may enter shall be such that the necessary space for wire bending and manipulation will remain between any wire connector, wiring lug, conduit knockout, or conduit hole and any wall of the wiring compartment that would cause the wire to bend, as specified in Table 9.2.

9.5 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 will be used, considering no less than 125 percent of the current the equipment will draw, and the minimum conductor size that would be needed if aluminum supply conductors are used.

9.6 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.

9.7 The accessibility for inspection required in paragraph 9.6 is considered to be acceptable if, after the heater has been installed in its intended operating position, the connections can be examined without using a tool of other than the ordinary type, such as an offset screw driver, and the like, 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.

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

Field-Wiring Terminals and Leads

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

TABLE 9.2
MINIMUM ACCEPTABLE 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
1	42.4	3	76.2

[a]If 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.

(TM-375)

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

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

Exception: Multiple leads, if provided, may be smaller than specified, but the sum of the conductor cross-sectional areas of such leads for any given pole shall be equivalent to the size specified in this paragraph; however, in no case shall any pigtail lead be smaller than No. 14 AWG (2.1 mm^2).

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

9.13 A field-wiring terminal shall be acceptable for the connection of either (1) a copper supply conductor only or (2) an aluminum or a copper supply conductor, in accordance with the marking described in paragraph 45.5.

9.14 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 may be used at a wiring terminal for the connection of a No. 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

9.15 A wiring terminal shall be prevented from turning.

9.16 If 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 may be used at a terminal intended only for the connection of a No. 14 AWG (2.1 mm^2) conductor.

9.17 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 acceptable if the tapped threads have equivalent mechanical strength.

9.18 A terminal plate may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

9.19 Upturned lugs or a cupped washer, if employed, shall be capable of retaining a No. 14 AWG (2.1 mm^2) or larger conductor under the head of the screw or washer provided to hold the wire in position.

9.20 A wire-binding screw shall thread into metal.

9.21 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.

10. Electrical Supply Connections — Cord Connection

Power Supply Cords

10.1 With respect to the exception of paragraph 9.2, a small capacity 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).

10.2 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 10.1.

10.3 A power supply cord provided on a small capacity storage tank water heater shall have conductors of the size specified in Table 10.1.

Bushings

10.4 At a point where a power supply cord passes through an opening in a wall, barrier, or enclosing case (1) there shall be a bushing or equivalent that is secured in place or (2) the opening shall have a smooth, rounded surface against which the cord may bear.

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

Strain Relief

10.6 Strain relief, other than a knot in a power supply cord, shall be provided such that mechanical stress on a power supply cord will not be transmitted to terminals, splices, or internal wiring, as determined by the strain relief test described in Section 35.

10.7 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 if such displacement is likely (1) to subject the cord to mechanical damage, (2) to expose the cord to a temperature higher than that for which it is rated, or (3) to reduce spacings to values below the minimum values specified in Table 11.1.

TABLE 10.1
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

(TM-376)

11. Electrical Spacings

General

11.1 The electrical spacings in a water heater shall be in accordance with Table 11.1.

Exception No. 1: The spacing requirements in Table 11.1 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 11.1.

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 acceptable between uninsulated live parts of opposite polarity and between uninsulated live parts and dead metal parts if (1) the heater is rated 250 volts or less and (2) the points in question are at other than wiring terminals.

11.2 An insulating lining or barrier of fiber or similar material employed where spacings would otherwise be 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 will not be adversely affected by arcing. Fiber no less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of no less than half the required spacing for air alone.

Exception: Insulating material having a thickness less than specified may be used if, upon investigation, it is determined that it will not be adversely affected by arcing.

11.3 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.

TABLE 11.1
MINIMUM ACCEPTABLE ELECTRICAL SPACINGS

		Minimum Acceptable Spacing			
		Through Air		Over Surface	
Location in Water Heater	Rated Voltage	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, but not connecting straps or busses extending from such terminals, between:					
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 can be 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

(TM-377)

Reduction of Spacings Due to Turning or Shifting

11.4 Wire mesh used to secure thermal insulation in a heater not provided with an outer enclosure shall be secured in place so that it cannot 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 11.1.

11.5 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 11.1.

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

12. Grounding

12.1 An exposed dead metal part of a heater that is likely to become energized under abnormal conditions and the tank shall be conductively connected to the point of connection of the power supply wiring system and the equipment-grounding terminal or lead. The storage tank is specifically included in this requirement.

Exception: The requirement for grounding does not apply to:

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

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

2. 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 no thinner than 0.028 inch (0.71 mm) and secured in place.

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

12.2 Unless the dead metal parts described in paragraph 12.1 are bonded together by mechanical fasteners, an individual bonding conductor or strap shall be used for this purpose.

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

12.4 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.

12.5 A separate component-bonding conductor shall be no smaller than the size specified in Table 12.1.

Exception No. 1: For a branch circuit overcurrent protective device rated no more than 30 amperes, a conductor smaller than required may be provided if 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 but no more than 50 amperes, a conductor smaller than required may be provided if the bonding connection does not open when carrying twice the rated current of the branch circuit overcurrent protective device for 4 minutes.

TABLE 12.1
GROUNDING/BONDING CONDUCTOR SIZE

Maximum Rating or Setting of Automatic Overcurrent Device in Circuit, Amperes[a]	Size of Grounding/Bonding Conductor[b]	
	Copper Wire AWG (mm^2)	Aluminum Wire 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 may be the same size as the current-carrying conductors.

[b]Or equivalent cross-sectional area.

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12.6 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 Section 32.

12.7 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 (1) switches, thermostats, wiring, or other electrical components are secured to the top or (2) when the top is in place, electrical components might contact it under conditions of distortion likely to be encountered in service. If neither condition prevails, the sliding contact is to be considered acceptable for the required electrical bonding connection.

12.8 A field-wiring terminal intended for the connection of an equipment-grounding conductor shall be provided. The terminal shall have a green colored head that is hexagonal shaped, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G," "GR," "GND," "Ground," "Grounding," or the like, or by a marking on a wiring diagram provided on the water heater.

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

Conductor Identification

12.10 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.

12.11 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 natural gray, and shall be readily distinguishable from the other lead or leads.

13. Reduction of Risk of Injury

Sharp Edges

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

13.2 The intended use and routine user maintenance referred to in paragraph 13.1 is considered to include cleaning of the outer enclosure, periodic draining of water from the tank, and similar operations, but does not include removal of a cover by means of a tool for the purpose of gaining access to a temperature control.

Stability

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

13.4 The stability of a water heater is to be investigated only if it has flexible water connections or is manually filled, and if 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.

Surface Temperatures

13.5 A surface that is subject to contact during operation, or that is likely to be contacted during user maintenance, shall not attain a temperature greater than the limits shown in Table 26.2.

14. Overcurrent Protection

14.1 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.

14.2 The overcurrent protection devices required in paragraph 14.1 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. If the overcurrent protection devices are provided as a separate assembly, the water heater and the overcurrent protection assembly shall be marked as required in paragraphs 45.7 and 45.8, respectively.

14.3 The overcurrent protection mentioned in paragraphs 14.1 and 14.2 shall be of a type rated for branch circuit protection. A cartridge fuse used for this purpose shall be a Class G (60 ampere maximum), H, J, K, R, or T. A plug fuse shall be used only in circuits of 125 volts maximum.

15. Materials in Contact with Water

General

15.1 A nonmetallic material in contact with water shall conform to the requirements of the National Sanitation Foundation Standard for Plastic Piping System Components and Related Materials, NSF No. 14-1978, and shall have a specific gravity greater than 0.94.

Dip Tubes

15.2 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.

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

15.4 A nonmetallic dip tube shall comply with the tests described in Section 34.

16. Current-Carrying Parts

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

16.2 Stainless steel and other corrosion-resistant alloys may be used for current-carrying parts in a water heater without restriction as to temperature. Plated iron or steel may be used for current-carrying parts if the material is subjected to a temperature higher than 100°C (212°F), but unplated iron or steel is not acceptable.

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

17. Internal Wiring

17.1 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.

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

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

17.4 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 acceptable for the combination of metals involved at the connection point.

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

17.6 Wiring within an enclosure, compartment, raceway, or the like shall be located or protected to reduce the likelihood of contact with any sharp edge, burr, fin, moving part, or the like that can damage the conductor insulation.

17.7 If 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. This can be accomplished by using pressure terminal connectors, soldering lugs, or crimped eyelets, by soldering all strands of the wire together, or by other equivalent means.

17.8 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.

18. Electrical Insulation

18.1 Insulating washers, bushings, and the like 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.

18.2 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 acceptable for use as the sole support of uninsulated live parts. Certain other materials that are not acceptable for general use, such as magnesium oxide, may be used only in conjunction with other more acceptable insulating materials or if located and protected so that mechanical injury and the absorption of moisture are not likely. If an investigation is necessary 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 may affect the risk of fire, electric shock, or injury to persons in conjunction with the conditions of actual service.

18.3 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.

19. Thermal Insulation

General

19.1 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 acceptable for such use. Thermal insulation in contact with wiring shall be nonabsorbent and resistant to combustion.

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

Exception: The investigation referred to in this paragraph may be waived if each water heater is subjected to a routine production line dielectric voltage-withstand test in accordance with paragraph 28.1. Alternatively, a 1 second application of a test potential of 1500 volts may be made on each heater rated at 250 volts or less, and a 1 second application of a test potential of 2500 volts may be made on each heater rated at more than 250 volts.

Polymeric Foam

19.3 If polymeric foam is used as thermal insulation:

A. The foam shall be completely enclosed by metal having a thickness as indicated in Tables 4.1 and 4.2;

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 respect to item 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, need not be enclosed in metal.

Exception No. 2: With respect to item A, polyvinyl chloride, polyethylene, or the equivalent may be used in place of enclosure metal at a plumbing connection if the opening at the connection does not exceed three times the diameter of the pipe.

Exception No. 3: With respect to item C, the foam may be in contact with internal wiring if the entrance and exit wiring holes are sealed with polyvinyl chloride grommets or sealing compound.

Exception No. 4: With respect to items C and D, the foam may be in contact with internal wiring, and the electrical components may be located less than 2 inches from the foam, if (1) the foam has a flame class rating of 94HF-1 or 94HF-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 (2) no fire occurs as a result of the electrical disturbance test described in Section 36.

Exception No. 5: With respect to item E, a foam that is not temperature rated as specified in UL 746B need not be subjected to temperatures exceeding the temperature recommendations documented by the foam manufacturer.

20. Heating Elements

General

20.1 A heating element shall be supported so that it will not be subject to mechanical abuse and contact with outside objects.

20.2 A wraparound element shall be secured in place so that it will not loosen. An investigation may be necessary to determine whether the construction complies with this requirement.

Sheathed Elements

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

20.4 Unless of the immersion type, a sheathed heating element shall be in an enclosure that complies with the requirements in Table 4.1.

21. Temperature-Regulating Controls

21.1 A heater having a tank that is not open to the atmosphere shall be subjected to the water temperature test specified in paragraph 27.1. The results are acceptable if the thermostat that controls each heating element limits the water temperature to 85°C (185°F) or less.

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

21.3 A temperature-regulating thermostat or control shall be set before leaving the factory to a control position corresponding to a temperature no higher than 60°C (140°F).

22. Temperature-Limiting Controls

22.1 A water heater with a tank closed to the atmosphere shall be provided with a 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 paragraph 27.2 regardless of the position of the actuating handle, button lever, or the like (that is, the control is "trip free");

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

22.2 With reference to item E of paragraph 22.1, a control that is either single pole or multipole is acceptable if 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.

22.3 The temperature-limiting control shall have no operating part in common with the temperature-regulating thermostat mentioned in paragraph 21.1, but a common mounting bracket or a common enclosure may be employed for both types of control.

22.4 If 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.

22.5 A control used in combination with a relay or contactor shall be subjected to an investigation.

23. Storage Tank

23.1 A storage tank shall withstand a hydrostatic pressure of two times its maximum working pressure, or 300 pounds per square inch gauge (2.07 MPa), whichever is greater, for 15 minutes without leakage or visible, permanent distortion, or the tank shall carry the symbol of the Boiler and Pressure Vessel Code, ANSI/ASME, BPV-1977, consisting of the Code H, HLW, or U in a clover leaf.

Exception: This requirement does not apply to a water heater having a tank open to the atmosphere.

23.2 The hydrostatic test mentioned in paragraph 23.1 shall be conducted in accordance with Section 33.

23.3 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 B2.1-1968.

D. Shall accommodate a 1/2 inch or larger trade-size pipe if the rating is less than 4.5 kilowatts, and shall accommodate a 3/4 inch or larger trade size pipe if the rating is 4.5 kilowatts or more.

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24. Power Input Test

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

24.2 To determine compliance with paragraph 24.1, the heater is to be connected to a supply circuit of voltage as specified in paragraph 24.3, and the power input is to be measured with the heater operating under full load conditions as described in paragraphs 26.2 — 26.10.

24.3 The supply voltage for the test described in paragraph 24.2 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.

Exception: If 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.

25. Insulation Resistance Test

25.1 A heating element employing insulating material that can be 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).

25.2 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.

26. Temperature Test

General

26.1 A water heater shall be subjected to the temperature tests described in paragraphs 26.2 — 26.15.

Maximum Load

26.2 A water heater shall be subjected to a heating test as specified in paragraphs 26.3 — 26.10. The results are acceptable if the temperature rise at specific points is no more than specified in Table 26.1, or if the temperature at any other point is not so high as to cause a fire or to affect adversely any material employed in the heater.

TABLE 26.1
MAXIMUM ACCEPTABLE TEMPERATURE RISES

	Materials and Components	°C	°F
1.	Varnished cloth insulation	60	108
2.	Fuses other than Class J	65[a]	117[a]
3.	Class J fuses	85[a]	153[a]
4.	Fiber employed 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 employed as electrical insulation or as a part whose failure would result in a risk of fire or electric shock[b]	125	225
7.	Rubber or thermoplastic insulated wires	35	63
8.	Impregnated asbestos insulated wire	100	180
9.	Any point within a terminal box or compartment of a permanently connected appliance[c]	35	63
10.	Sealing compounds	d	d
11.	Capacitors	25 less than marked limit	45
12.	Copper or copper base alloy conductor (bare or insulated) without tinning, nickel coating, or silver plating, except as noted in item 13	175	315
13.	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

(Continued)

TABLE 26.1 (Cont'd)
MAXIMUM ACCEPTABLE TEMPERATURE RISES

[a]A fuse that has been investigated and found acceptable for use at a higher temperature may be used at that temperature.

[b]The limitations 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]It is to be assumed that field installed conductors or splices can touch the tank or other parts located in or back of the terminal box or compartment even though such components are covered with thermal insulation.

[d]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 for Softening Point by Ring and Ball Apparatus, ASTM E28-1967.

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26.3 To determine compliance with paragraph 26.2, 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 will permit so that maximum heating of the walls will occur. Temperatures are to be observed on nearby surfaces, on the supporting surface, at points of support, and at other points as may be necessary. The supply voltage is to be as described in paragraph 24.3.

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

26.5 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 paragraph 26.9.

26.6 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.

26.7 All values for temperature rises in Table 26.1 are based on an assumed ambient temperature of 25°C (77°F). However, tests may be conducted at any ambient temperature within the range of 10 — 40°C (50 — 104°F).

26.8 Temperatures are to be measured by thermocouples consisting of wires no larger than No. 24 AWG (0.21 mm^2) and no smaller than No. 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 No. 30 AWG iron and constantan wire and a potentiometer type instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

26.9 A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but no less than 5-minute intervals), indicate no change. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements for special thermocouples as listed in the table of limits of error of thermocouples in Temperature Measurement Thermocouples, ANSI MC96.1-1975.

26.10 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 necessary thermal contact results from taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

Surface Temperatures

26.11 During the test described in paragraphs 26.2 — 26.10, temperature readings are to be observed on surfaces of the heater that are accessible to contact by persons while the heater is in use. Results are acceptable if these temperatures do not exceed the maximum values given in Table 26.2.

TABLE 26.2
MAXIMUM ACCEPTABLE SURFACE TEMPERATURES[a]

	Surface Height Above Floor			
	Less Than 36 Inches (0.91 m)		36 Inches (0.91 m) or More	
Surface Material	°C	°F	°C	°F
Bare or Painted metal	67	153	83	181
Porcelain enamel	71	160	88	190
Glass	78	172	94	201
Plastic[b]	83	181	100	212

[a]All temperature limits are based on a 25°C (77°F) ambient temperature.

[b]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.

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Dry Operation

26.12 If the conditions of maximum load as described in paragraphs 26.2 — 26.10 do not represent all the conditions of abnormal operation that are likely to occur in actual service, a water heater shall be subjected to the test specified in paragraph 26.13.

Exception: The dry operation test described in paragraph 26.13 need not 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.

26.13 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.

26.14 When operated under such conditions, the results are judged to be acceptable if there is no emission of flame or molten metal, or if 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.

26.15 After the completion of the test described in paragraph 26.12, the likelihood of electric shock is to be determined by repeating the insulation resistance measurement described in Section 25 and the dielectric voltage-withstand test described in Section 28.

27. Water Temperature Test

27.1 To determine compliance with paragraph 21.1, the heater is to be operated as described in paragraph 26.6, 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.

27.2 To determine compliance with paragraph 22.1, 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 paragraph 27.3, 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, but unusual conditions may necessitate use of a probe or thermocouple within the tank.

27.3 In accordance with paragraph 27.2, the temperature-regulating thermostats are to be short-circuited as follows:

A. If 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.

B. If 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.

28. Dielectric Voltage-Withstand Test

28.1 A water heater shall be subjected to the application of a 60 hertz essentially 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 paragraphs 26.2 — 26.10. 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 results are acceptable if there is no dielectric breakdown.

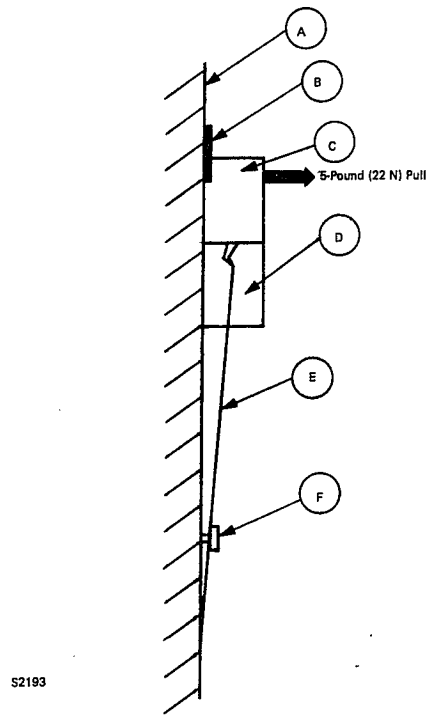
28.2 To determine compliance with paragraph 28.1, the heater is to be tested by means of a 500 volt-ampere or larger capacity testing transformer, the output voltage of which can be varied. Starting at zero, the applied potential is to be increased until the required test value is reached and to be held 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.

29. Mounting Test of Surface-Mounted Temperature Controls

Horizontal Pull

29.1 To determine that a surface-mounted temperature control is securely mounted to the water heater tank as required in paragraph 5.2, a direct pull of 5 pounds (22 N) is to be applied to the control at the point most likely to result 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 29.1. The pull is to be applied for 5 seconds, and then released. The results are acceptable if, after the pull has been applied and released, a test strip of metal or plastic 1/64 inch (0.4 mm) thick cannot be 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 29.1
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

Supply Lead Pull

29.2 To determine compliance with paragraph 5.2, 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 would result in the maximum stress on the control that the construction permits. The force is to be applied from the supply wiring compartment. The results are acceptable if the control is not dislodged from the mounting means.

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

30. Barrier Pull Tests

30.1 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 item B of paragraph 6.4, a direct force of 3 pounds (13.3 N) is to be applied to the barrier or cover at those points most likely to 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 results are acceptable if the barrier or cover is not displaced enough to expose uninsulated live parts.

30.2 To determine that a barrier held in place by two independent means complies with item D of paragraph 6.4, a direct horizontal pull of 3 pounds (13.3 N) is to be applied to the barrier at the point most likely to result in displacement of the barrier. The results are acceptable if the barrier is not dislodged, and uninsulated live parts are not exposed.

31. Water Capacity Test

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

31.2 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.

32. Grounding-Circuit Resistance Measurement Test

32.1 To determine compliance with paragraph 12.6, any convenient method may be used to measure grounding-circuit resistance, but if unacceptable high resistance measurements are obtained, a referee test is to be conducted in accordance with paragraph 32.2.

32.2 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 may be 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.

33. Storage Tank Hydrostatic Pressure Test

33.1 In a test to determine compliance with paragraph 23.1, the pressure is to be increased from atmospheric pressure at a rate of approximately 20 pounds per square inch gauge (137.9 kPa) per second. When the specified test pressure as determined in paragraph 23.1 is reached, that pressure is then to be maintained for 15 minutes.

34. Nonmetallic Dip Tube Tests

Deformation of Weight Loss

34.1 A nonmetallic dip tube is to (1) have a linear deformation not in excess of 1/2 inch (12.7 mm), (2) have a total lateral deformation not in excess of 1-1/2 inches (38.1 mm), and (3) undergo no weight loss when tested in accordance with the requirements of paragraphs 34.2 — 34.4.

34.2 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.

34.3 Linear deformation is to be determined by suspending the samples as they would be 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 to be considered as evidence of noncompliance.

34.4 Lateral deformation is to be determined by installing one end of each sample in a fixture (as it would be 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 acceptable if 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.

Resistance to Crushing

34.5 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 paragraphs 34.6 — 34.9.

34.6 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 34.1.

FIGURE 34.1
HEAT DEFORMATION TESTER

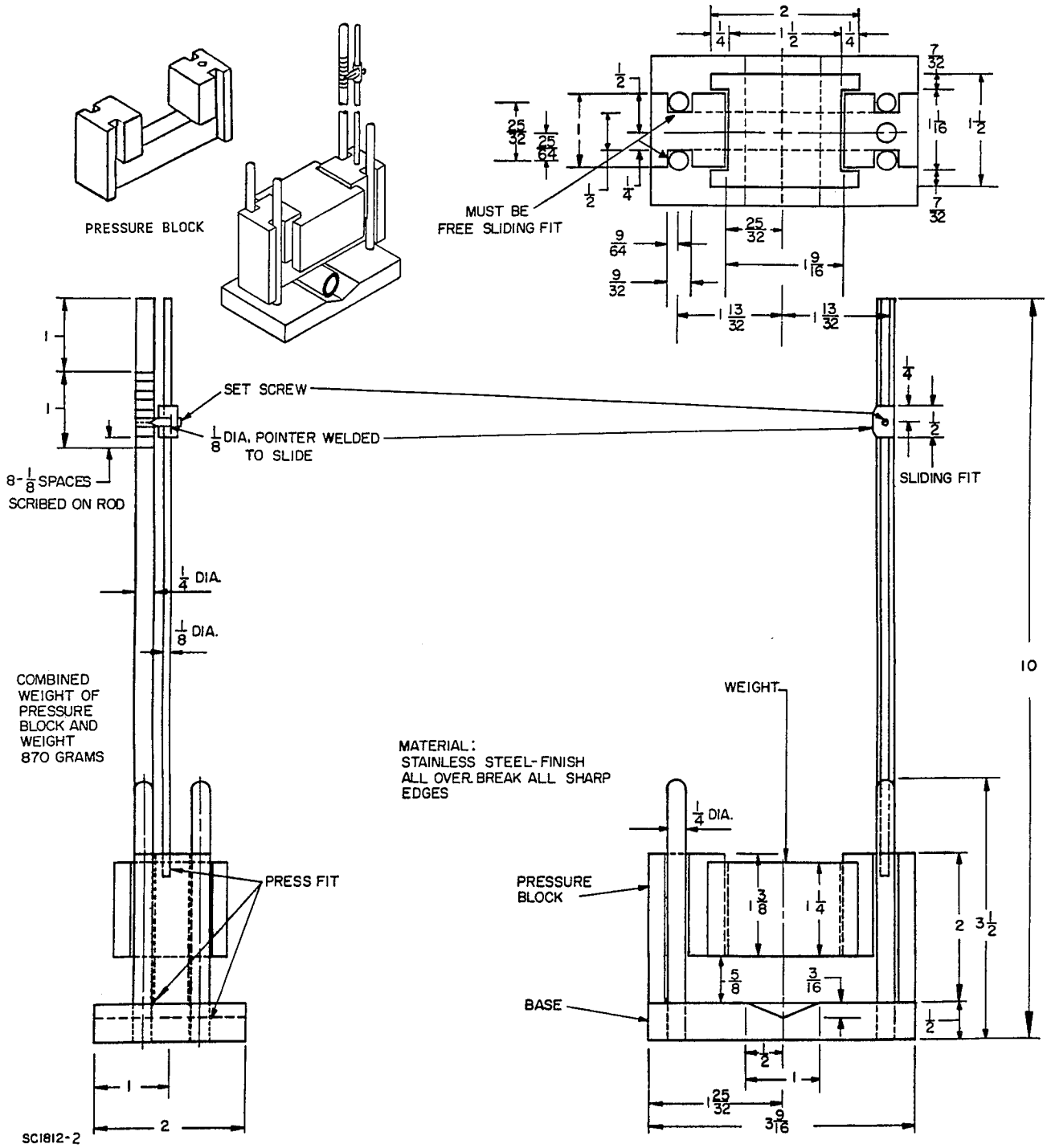


TABLE OF SI EQUIVALENTS FOR FIGURE 34.1

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

34.7 The scale on the test apparatus shown in Figure 34.1 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 sufficient 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.

34.8 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.

34.9 The results are acceptable if 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 considered as noncompliance of the lot submitted for test.

Collapse

34.10 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 paragraphs 34.11 — 34.15.

34.11 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 paragraphs 34.12 — 34.15.

34.12 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 B36.10-1979, 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.

34.13 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 will be 40 psig (276 kPa).

34.14 The storage vessel is to be filled and the test water heater placed in operation, with the thermostat, if any, 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.

34.15 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 considered as noncompliance with this requirement.

35. Strain Relief Test

35.1 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 paragraph 35.2.

35.2 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 will be stressed from any angle, as determined by the construction of the water heater. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is movement of the cord to indicate that stress on the connections would have resulted.

36. Electrical Disturbance Test of Foam Thermal Insulation

36.1 In accordance with exception No. 4 of paragraph 19.3, 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.

36.2 A fault is to be induced in a wire by peeling or stripping back the wire insulation approximately 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.

36.3 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 36.1, is then to be made to flow through the circuit.

36.4 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 36.1. The results are acceptable if, 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. If at any time during the test, the wiring opens and an arc ignites the foam, the results are unacceptable and the test is to be concluded.

36.5 With regard to the test described in paragraph 36.4, if 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 paragraph 36.2, and the test is to be continued from the point in the test that the wire opened.

TABLE 36.1
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

(TM-381)

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

37. Leakage Current Test

37.1 A cord- and plug-connected water heater shall be tested in accordance with paragraphs 37.2 — 37.7. The results are acceptable if the leakage current does not exceed 0.75 milliampere.

37.2 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.

37.3 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 if simultaneously accessible, and from one such surface to another if simultaneously accessible. A surface is considered to be exposed unless protected against inadvertent contact by an enclosure or the equivalent that meets the requirements of Section 4. Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are considered not to involve a risk of electric shock.

37.4 If 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 100 by 200 mm, the piece of metal foil is to be the same size as the surface.

37.5 The measurement circuit for leakage current is to be as shown in Figure 37.1. The defined measurement instrument is as specified in items A — D. The meter that is actually used for a measurement need only indicate the same electrical value for a particular measurement as would the defined instrument; it need not have all the attributes of the defined instrument.

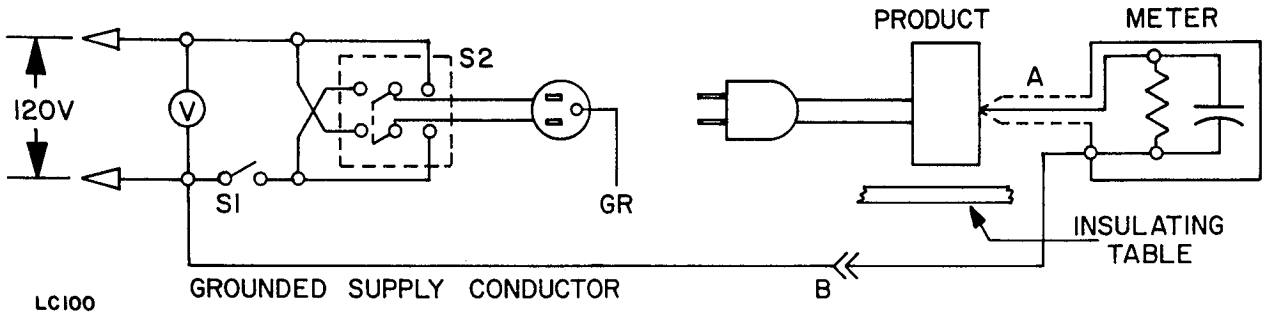
A. The defined meter has an input impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor.

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.

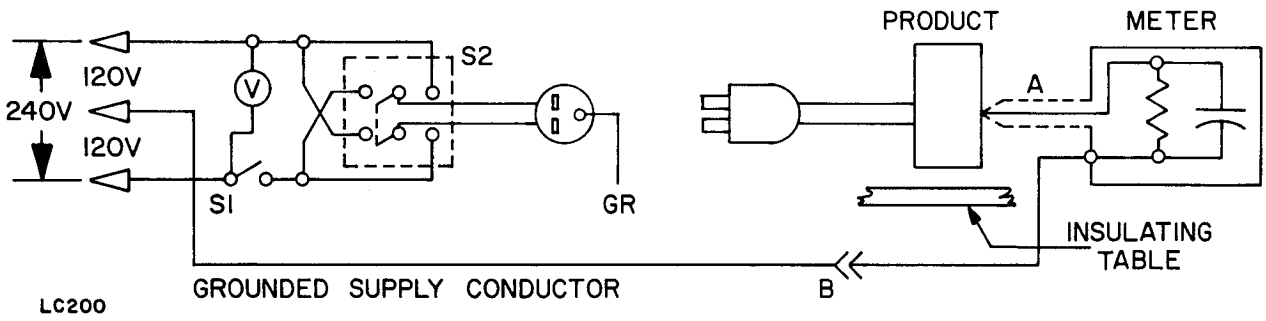
C. The defined meter, over a frequency range of 0 — 100 kilohertz, has a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to a 1500 ohm resistor. At an indication of 0.75 milliampere, the measurement 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 37.1
LEAKAGE CURRENT MEASUREMENT CIRCUITS



Appliance intended for connection to a 120 volt power supply.



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.

37.6 A sample of the appliance is to be tested for leakage current starting with the as-received condition but with its grounding conductor open at the attachment plug. In the as-received condition, the appliance has not been previously energized except as may have occurred during production line testing. The supply voltage sequence with reference to the measurement circuits shown in Figure 37.1 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.

37.7 A sample will 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 may be interrupted for the purpose of conducting other nondestructive testing.

38. Permanence of Markings

38.1 The markings required in Sections 42 — 45 shall be located on the enclosure or on a part that would either require a tool for removal or, if removed, would impair operation of the appliance. In addition, a marking that is required to be permanent shall be (1) etched, (2) molded, (3) die stamped, (4) paint stenciled, (5) permanently secured, stamped or etched metal, or (6) indelibly stamped lettering on pressure sensitive labels secured by adhesive. Pressure sensitive labels secured by adhesive shall comply with the requirements for marking and labeling systems, UL 969. Usage, in handling, storage, and the like, of the appliance will be considered in determination of permanence of marking.

MANUFACTURING AND PRODUCTION TEST

39. Production Line Dielectric Voltage-Withstand Test

39.1 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 (1) between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized, and (2) between primary wiring and accessible low voltage (42.4 volts peak or less) metal parts, including terminals. The results are acceptable if there is no dielectric breakdown.

39.2 The production line test shall be in accordance with either Condition A or Condition B of Table 39.1.

TABLE 39.1
PRODUCTION LINE TEST CONDITIONS

Appliance Rating, Volts	Condition A		Condition B	
	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, but no less than 240 volts.

(TM-382)

39.3 The appliance may be in a heated or unheated condition for the test.

39.4 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 would interfere with conducting the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the complete appliance.

39.5 When the appliance employs a solid state component that is not relied upon to reduce the risk of electric shock and that can be damaged by the dielectric potential, the test may be conducted before the component is electrically connected, provided a random sampling of each day's production is tested at the potential specified in Table 39.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid state component damage while retaining the representative dielectric stress of the circuit.

39.6 The investigation of thermal insulation mentioned in paragraph 19.2 need not be conducted if each water heater is subjected to a routine production line dielectric voltage-withstand test in accordance with Section 28. 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.

39.7 The test equipment is to include a transformer having an essentially 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 an unacceptable unit.

39.8 If 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.

39.9 If the rated output of the test equipment transformer is 500 volt-amperes or larger, the test potential may be indicated (1) by a voltmeter in the primary circuit or in a tertiary winding circuit, (2) by a selector switch marked to indicate the test potential, or (3) 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.

39.10 Test equipment other than that described in paragraphs 39.7 — 39.9 may be used if found to accomplish the intended factory control.

39.11 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: An appliance (resistive, high impedance winding, or the like) having circuitry not subject to excessive secondary voltage build-up in case of dielectric breakdown during the test may be tested (1) with a single pole primary switch, if used, in the off position or (2) 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 if the testing means applies full test potential between primary wiring and dead metal parts with the switch not in the on position.

RATINGS

40. Electrical

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

40.2 The rated voltage of a water heater having a marked voltage range (such as 110 — 120 volts) is to be considered the maximum voltage of the range.

41. Tank Pressure and Capacity

41.1 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 paragraph 23.1.

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

MARKINGS AND INSTRUCTIONS

42. Identification

42.1 A water heater shall be legibly and permanently marked, where readily visible after installation, with the manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product may be identified, the date or other dating period of manufacture not exceeding any three consecutive months, which may be abbreviated or in a nationally accepted conventional code, or a code affirmed by the manufacturer, a distinctive catalog or model number or the equivalent, and the electrical rating.

42.2 The repetition time cycle of the date code mentioned in paragraph 42.1 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.

42.3 If a manufacturer produces water heaters of the same model or catalog number at more than one factory, each heater shall bear a marking (that may be in code) that will identify it as the product of the particular factory.

42.4 A nonmetallic (1) dip tube, (2) heat trap tube, or (3) inlet water deflector 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 paragraph 15.1.

43. Ratings

43.1 A water heater shall be permanently marked where readily visible with its electrical ratings, and if 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.

43.2 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".

43.3 If 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 can operate at a time, the "maximum wattage or current consumption" mentioned in paragraph 43.1 is to be considered to be that of the single element having the highest input rating.

43.4 If replaceable in the field, a heating element rated at more than 1 ampere shall be plainly and permanently marked with either (1) its electrical ratings in amperes or watts, and volts, or (2) the manufacturer's part number, or both.

43.5 The maximum working pressure and the total water capacity of a heater, as described in paragraphs 41.1 and 41.2, for the storage tank that operates at other than atmospheric pressure and, if applicable, the ASME Code symbol specified in paragraph 23.1, shall be plainly and permanently marked on the exterior of the water heater. If 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.

43.6 A water heater rated more than 16.0 but 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.

44. Warning Notices

44.1 If 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.

44.2 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 Section 44.

44.3 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".

44.4 A water heater provided with an adjustable temperature-regulating control shall be marked with the word "CAUTION", and the following or the equivalent: "Hotter water increases the risk of scald injury. Before changing temperature setting see instruction manual". The marking shall be permanent and shall be located adjacent to the thermostat compartment cover so as to be visible both before removal of the cover and when the operator is making adjustments to the thermostat. If more than one thermostat is provided, a marking shall be located adjacent to each thermostat or a single marking may be centrally located between the thermostats.

44.5 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".

44.6 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".

45. Informational Markings

45.1 A water heater shall be plainly and permanently marked with the following statement: "Install temperature and pressure protective equipment required by local codes, but not 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 Z21.22-1979 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".

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

45.3 If 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.

45.4 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".

45.5 In accordance with paragraph 9.13, 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 paragraph 42.1, and shall be independent of any other marking on terminal connectors. The marking shall be visible during and after installation of the heater.

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

45.7 If required overcurrent protective devices are provided as a separate assembly in accordance with paragraph 14.2, 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".

45.8 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.

46. Instructions

Temperature and Pressure Relief Valve

46.1 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 but not 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 Z21.11-1979. 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 will exit only within 6 inches above or at any distance below the structural floor and cannot contact any live electrical part. The discharge opening must not be blocked or reduced in size under any circumstances".

Thermostat Setting

46.2 A water heater equipped with an adjustable temperature-regulating control shall be provided with instructions that (1) inform the user that the thermostat has been set at the factory to 60°C (140°F) or lower to reduce the risk of scald injury, (2) inform the user how to change this setting if the user so desires, and (3) include any necessary precautions to be followed in changing the setting.

Cathodic Protection

46.3 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 can be produced in a hot water system served by this heater that has not been used for a long period of time (generally 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. If 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".

Grounding

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

Safety Instructions

46.5 A cord- and plug-connected water heater shall be provided with the Important Safety Instructions specified in paragraphs 46.6 — 46.9.

46.6 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", "SAVE THESE INSTRUCTIONS", and the like shall be in letters no less than 3/16 inch (4.8 mm) high.

46.7 The instructions described in paragraph 46.9 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.

46.8 Unless otherwise indicated, the instructions described in paragraph 46.9 shall be in the exact words specified or shall be in equally definitive terminology.

46.9 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.

SAVE THESE INSTRUCTIONS

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are judged include the following:

Title of Standard — UL Standard Designation

Attachment Plugs and Receptacles, Electrical — UL 498
Circuit Breakers, Molded-Case, and Circuit-Breaker Enclosures — UL 489
Flexible Cord and Fixture Wire — UL 62
Fuseholders — UL 512
Fuses, Class H — UL 198B
Fuses, Class R — UL 198E
Fuses, Class T — UL 198H
Fuses for Supplementary Overcurrent Protection — UL 198G
Fuses, Class K, High-Interrupting-Capacity — UL 198D
Fuses, High-Interrupting-Capacity, Current-Limiting Types — UL 198C
Fuses, Plug — UL 198F
Heating Elements, Sheathed — UL 1030
Marking and Labeling Systems — UL 969
Outlet Boxes and Fittings, Electrical — UL 514
Polymeric Materials - Long Term Property Evaluations — UL 746B
Polymeric Materials - Short Term Property Evaluations — UL 746A
Polymeric Materials - Use in Electrical Equipment Evaluations — UL 746C
Temperature-Indicating and -Regulating Equipment, Electrical — UL 873
Terminal Blocks, Electrical — UL 1059
Terminals, Quick-Connect — UL 310
Thermal Cutoffs for Use in Electrical Appliances and Components — UL 1020
Wire Connectors and Soldering Lugs for Use with Copper Conductors — UL 486A
Wire Connectors for Use With Aluminum Conductors — UL 486B
Wire Connectors, Splicing — UL 486C
Wires and Cables, Thermoplastic-Insulated — UL 83

SUPPLEMENT A — ELECTRIC STORAGE TANK WATER HEATERS FOR MARINE USE

INTRODUCTION

SA1. Scope

SA1.1 The requirements in this supplement cover electric storage tank water heaters intended to be installed aboard boats or vessels.

SA1.2 The water heaters covered by the requirements in this supplement are intended for installation in accordance with the requirements of the Standard for Fire Protection of Pleasure and Commercial Motorcraft, NFPA 302; the American Boat and Yacht Council, Inc.; and the United States Coast Guard (as specified in 33 CFR 183 Subpart I — Electrical Systems or 46 CFR Subchapter J — Electrical Engineering), as applicable.

SA1.3 A water heater intended for marine use shall comply with the requirements in Sections 2 — 46, as applicable, except as modified or superseded by the requirements in this supplement.

SA2. Glossary

SA2.1 For the purposes of this supplement the following definition applies.

SA2.2 IGNITION-PROTECTED — A water heater constructed such that (1) a flammable hydrocarbon mixture surrounding the water heater will not be ignited if a normally occurring electrical arc, spark, or heat source ignites a flammable hydrocarbon mixture inside the electrical controls; (2) the electrical arc, spark, or heat source has insufficient electrical or heat energy to ignite the flammable mixture; or (3) the source of ignition is hermetically sealed from the surrounding mixture. An ignition-protected water heater does not necessarily comply with the requirements for an explosion-proof device as applied to U. S. Coast Guard inspected vessels or as defined by the National Electrical Code, ANSI/NFPA 70-1987.

CONSTRUCTION

SA3. General

SA3.1 A water heater shall be provided with means for securement to a structural platform, deck, or bulkhead. The means shall acceptably reduce the likelihood of movement of the heater and strain on connecting pipe or tubing when installed as intended.

SA3.2 A water heater shall be constructed to withstand (1) the vibration and shock likely to be encountered in the application without malfunction of the mounting means, electrical connections, or storage tank; (2) the reduction in electrical spacings to less than the minimum acceptable values; or (3) the defeat of the ignition-protected feature (if applicable) when subjected to the vibration test described in Section SA7, and the shock test described in Section SA8.

SA3.3 A water heater shall not incorporate magnesium metal in any parts or components.

Exception: An anode inside a storage tank may incorporate magnesium metal.

SA4. Electrical Supply Connections

SA4.1 Flexible cord may be specified or provided for making electrical supply connections. The cord shall be:

A. A Type SO, SJO, STO, ST, SJT, or SJTO cord having insulation with moisture-resistant and flame-retardant characteristics acceptable for a marine environment.

B. Rated for the voltage and current involved in the application.

C. No less than 2 feet (610 mm) nor more than 5 feet (1.5 m) long as measured from the entrance of the cord into the heater to the face of the attachment plug.

Exception: Cord of a type acceptable for extra-hard service (Type ST, SO, or the equivalent) may be more than 5 feet long.

D. Provided with strain relief that complies with the strain relief test described in Section SA10.

SA5. Internal Wiring

SA5.1 Internal wiring shall be Type 2 stranded copper conductor having insulation with moisture-resistant and flame-retardant characteristics acceptable for a marine environment in accordance with Table 8-14.4 of the Fire Protection Standard for Marinas and Boatyards, NFPA 302.

SA6. Temperature-Limiting Controls

SA6.1 With respect to item C of paragraph 22.1, the temperature-limiting means of the heater need not be of the manually reset type provided the control (1) does not reclose at temperatures above minus 35°C (minus 31°F) and (2) is not of the replaceable element type.

PERFORMANCE

SA7. Vibration Test

SA7.1 A water heater shall withstand 12 hours of vibration without (1) leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; (2) reduction of electrical spacings to less than minimum acceptable values; or (3) defeat of the ignition-protected feature as described in paragraph SA9.1. Following the conditioning described in paragraph SA7.3, the sample is to be subjected to the power input test described in Section 24. The sample shall operate as intended and shall comply with the requirement in paragraph 24.1.

Exception: A product marked in accordance with the requirement in paragraph SA11.1 need not be subjected to this test.

SA7.2 A sample is to be mounted to the platform of a vibration machine in accordance with the manufacturer's installation instructions and connected to a source of rated supply by means of a flexible cord. One-foot (305-mm) lengths of Schedule 80 pipe of the size intended for use are to be threaded into the inlet and outlet openings of the sample. The sample is to be filled with water through the pipe threaded into the inlet opening, and the pipe ends are then to be capped. If specified in the installation instructions, a pressure-relief valve is to be installed.

SA7.3 The sample is to be subjected to a variable-frequency vibration test along each of three rectlinear axes (two perpendicular horizontal axes and a vertical axis) for 4 hours in each plane at a peak-to-peak amplitude (total platform displacement) of 0.020 ± 0.002 inch (0.51 ± 0.05 mm). The frequency of vibration is to be continuously varied, at a uniform rate, from 10 to 60 to 10 cycles per second every 4 minutes.

SA8. Shock Test

SA8.1 A water heater shall withstand 1000 shock impacts without (1) leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; (2) reduction of spacings to less than the minimum acceptable values; or (3) defeat of the ignition-protected feature as described in paragraph SA9.1. Following the conditioning described in paragraph SA8.3, the sample is to be subjected to the power input test described in Section 24. The sample shall operate as intended and shall comply with the requirement in paragraph 24.1.

Exception: A product marked in accordance with the requirement in paragraph SA11.1 need not be subjected to this test.

SA8.2 The sample used for the vibration test described in Section SA7 is to be used for this test. The sample is to be mounted on the platform of a shock machine, as specified in paragraph SA7.2, with its center of gravity as close as possible to the center of gravity of the machine platform.

SA8.3 The sample is to be subjected to 1000 vertical shock impacts, each having a 10 g peak acceleration [322 feet per second per second (98 m/s^2)] and a duration of 20 to 25 milliseconds as measured at the base of the half sine shock envelope.

SA9. Ignition Protection Test

SA9.1 A water heater intended for installation in an area requiring ignition protection shall not ignite a surrounding propane-air mixture when tested in accordance with the requirements for ignition protection test for marine products, UL 1500. Also, see paragraphs SA11.2 and SA11.3.

SA9.2 For a water heater not marked as specified in paragraph SA11.1, the sample subjected to the vibration test described in Section SA7 and the shock test described in Section SA8 is to be used for this test.

SA10. Strain Relief Test

SA10.1 The strain relief means of a power supply cord shall withstand for 1 minute, without displacement, a 35-pound pull (156 N) applied to the cord.

SA10.2 Internal connections of the conductors of the supply cord are to be disconnected. The specified weight is then to be suspended on the cord and supported by the water heater so that the strain relief means will be stressed from any angle that the construction permits. The strain relief is not acceptable if, at the point at which the conductors of the cord are disconnected, there is sufficient movement of the cord to indicate that stress would be transmitted to connections.

MARKINGS

SA11. Identification

SA11.1 A water heater not shown to comply with the requirements of the vibration test described in Section SA7 or shock test described in Section SA8 shall be permanently marked, where readily visible after installation, with the following or the equivalent: "For Use on Vessels Over 65 Feet in Length".

SA11.2 Only a water heater that is considered to be acceptable in accordance with the conditions of the ignition protection test described in Section SA9 may be marked "Ignition Protected".

SA11.3 A water heater that is not considered to be acceptable in accordance with the conditions of the ignition protection test described in Section SA9 shall be plainly and permanently marked with the word "CAUTION" and the following or the equivalent: "Possible ignition source. Do not install in areas where ignition protection is required".