

# UL 174

ISBN 0-7629-0973-0

## Household Electric Storage Tank Water Heaters

*UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL*

*UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL*

Underwriters Laboratories Inc. (UL)  
333 Pfingsten Road  
Northbrook, IL 60062-2096

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

Eleventh Edition, Dated April 29, 2004

Revisions: This Standard contains revisions through and including May 19, 2006.

### **Summary of Topics**

***These editorial revisions to ANSI/UL 174 replace all references to UL 1020, the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, with reference to UL 60691, the Standard for Thermal-Links – Requirements and Application Guide. UL 1020 was withdrawn and superseded by UL 60691.***

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due to relocation of existing text and reformatting of the Standard.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with the corresponding reference:

Future Effective Date	References
November 4, 2006	Paragraphs 49.9 and 49.10

The revisions dated May 19, 2006 include a reprinted title page (page1) for this Standard.

The revisions dated May 19, 2006 editorially replace all references to UL 1020 with the reference to UL 60691.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfolnet.ul.com/ulforeword.html>

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

UL's Standards for Safety are copyrighted by UL. Neither a printed copy of a Standard, nor the distribution diskette for a Standard-on-Diskette and the file for the Standard on the distribution diskette should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

Copyright © 2006 Underwriters Laboratories Inc.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1.....	May 19, 2006
2-3 .....	November 4, 2005
4 .....	April 29, 2004
5-6B .....	November 4, 2005
7-51 .....	April 29, 2004
52.....	July 22, 2004
53-58 .....	November 4, 2005
SA1 .....	July 22, 2004
SA2-SA6 .....	April 29, 2004
A1 .....	May 19, 2006
A2 .....	April 29, 2004
SR1-SR2.....	November 4, 2005

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

**APRIL 29, 2004**  
(Title Page Reprinted: May 19, 2006)



**ANSI/UL 174-2005**

1

## **UL 174**

### **Standard for Household Electric Storage Tank Water Heaters**

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

#### **Eleventh Edition**

**April 29, 2004**

The most recent designation of ANSI/UL 174 as an American National Standard (ANSI) occurred on October 27, 2005.

This ANSI/UL Standard for Safety, which consists of the Eleventh edition with revisions through May 19, 2006, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

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 set of revised requirements.

**ISBN 0-7629-0973-0**

**COPYRIGHT © 1977, 2006 UNDERWRITERS LABORATORIES INC.**

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

## CONTENTS

### INTRODUCTION

1 Scope .....	.6A
2 Components .....	.6A
3 Units of Measurement .....	.7
4 Undated References .....	.7
5 Glossary .....	.7

### CONSTRUCTION

6 Frame, Enclosures, and Outer Jacket .....	.8
6.1 General .....	.8
6.2 Enclosures .....	.8
6.3 Outer jacket .....	.9
7 Mechanical Assembly .....	.11
8 Accessibility of Live Parts .....	.12
9 Wetting of Live Parts .....	.13
10 Corrosion Resistance .....	.13
10.1 General .....	.13
10.2 Storage tanks .....	.13
11 Electrical Supply Connections – Permanent Connection .....	.13
11.1 General .....	.13
11.2 Field-wiring compartment .....	.14
11.3 Field-wiring terminals and leads .....	.15
12 Electrical Supply Connections – Cord Connection .....	.16
12.1 Power supply cords .....	.16
12.2 Bushings .....	.17
12.3 Strain relief .....	.17
13 Electrical Spacings .....	.18
13.1 General .....	.18
13.2 Reduction of spacings due to turning or shifting .....	.19
14 Grounding .....	.19
14.1 General .....	.19
14.2 Conductor identification .....	.22
15 Reduction of Risk of Injury .....	.22
15.1 Sharp edges .....	.22
15.2 Stability .....	.22
15.3 Surface temperatures .....	.23
16 Overcurrent Protection .....	.23
17 Materials in Contact with Water .....	.23
17.1 General .....	.23
17.2 Dip tubes .....	.23
17.3 Polymeric storage tank liner .....	.24
18 Current-Carrying Parts .....	.24
19 Internal Wiring .....	.24
20 Electrical Insulation .....	.25
21 Thermal Insulation .....	.25
21.1 General .....	.25
21.2 Polymeric foam .....	.26
22 Heating Elements .....	.27

**UL COPYRIGHTED MATERIAL –**

**NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

22.1	General	27
22.2	Sheathed elements	27
23	Temperature-Regulating Controls	27
24	Temperature-Limiting Controls	27
25	Storage Tank	28

## PERFORMANCE

26	Power Input Test	29
27	Insulation Resistance Test	29
28	Temperature Test	29
28.1	General	29
28.2	Maximum load	30
28.3	Surface temperatures	32
28.4	Dry operation	32
29	Water Temperature Test	33
30	Dielectric Voltage-Withstand Test	33
31	Mounting Test of Surface-Mounted Temperature Controls	34
31.1	Horizontal pull	34
31.2	Supply lead pull	36
32	Barrier Pull Tests	36
33	Water Capacity Test	36
34	Grounding-Circuit Resistance Measurement Test	36
35	Storage Tank Hydrostatic Pressure Test	37
36	Nonmetallic Dip Tube Tests	37
36.1	Deformation of weight loss	37
36.2	Resistance to crushing	38
36.3	Collapse	40
37	Strain Relief Test	41
38	Push Back Relief Test	41
39	Electrical Disturbance Test of Foam Thermal Insulation	41
40	Leakage Current Test	42
41	Enclosure Strength Test	45
42	Permanence of Markings	45

## MANUFACTURING AND PRODUCTION TEST

43	Production Line Dielectric Voltage-Withstand Test	46
----	---	----

## RATINGS

44	Electrical	48
45	Tank Pressure and Capacity	48

## MARKINGS

46	Identification	48
47	Ratings	49
48	Warning Notices	50
49	Informational Markings	53

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

**INSTRUCTIONS**

50 General .....	.55
51 Safety Instructions .....	.56

**SUPPLEMENT SA - ELECTRIC STORAGE TANK WATER HEATERS FOR MARINE USE****INTRODUCTION**

SA1 Scope .....	.SA1
SA2 Glossary .....	.SA1

**CONSTRUCTION**

SA3 General .....	.SA2
SA4 Electrical Supply Connections .....	.SA2
SA5 Internal Wiring .....	.SA3
SA6 Temperature-Limiting Controls .....	.SA3

**PERFORMANCE**

SA7 Vibration Test .....	.SA3
SA8 Shock Test .....	.SA4
SA9 Ignition Protection Test .....	.SA4
SA10 Strain Relief Test .....	.SA4

**MARKING**

SA11 Identification .....	.SA5
---------------------------	------

**APPENDIX A**

Standards for Components.....	A1
-------------------------------	----

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

## INTRODUCTION

### 1 Scope

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

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

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

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

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

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

### 2 Components

2.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the Standards for Components appendix for a list of standards covering components generally used in the products covered by this standard.

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

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

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

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

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

### 3 Units of Measurement

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

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

### 4 Undated References

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

### 5 Glossary

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

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

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

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

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

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

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

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

## CONSTRUCTION

### 6 Frame, Enclosures, and Outer Jacket

#### 6.1 General

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

#### 6.2 Enclosures

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

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

**Table 6.1**  
**Minimum thickness of sheet-metal enclosures**

	Sheet steel				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)

**Table 6.2**  
**Minimum thickness of cast metal enclosures**

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

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

- a) Mechanical strength;
- b) Resistance to impact; and
- c) Combustibility under conditions of intended or abnormal use.

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

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

- a) A tank capacity of five gallons (18.9 L) or less; and
- b) A power-supply cord provided in accordance with *Electrical Supply Connections – Cord Connection, Section 12.*

### 6.3 Outer jacket

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

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

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

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

- a) Does not enclose any current-carrying parts; or
- b) Encloses parts that are completely covered with minimum 1/32 inch (0.8 mm) thick electrical insulation.

**Table 6.3**  
**Polymeric material enclosure application code**

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

**Table 6.4**  
**Polymeric material enclosure property and test requirements**

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

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

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

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

<sup>d</sup> Tests are to be conducted in accordance with UL 746C.

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

**Table 6.5  
Polymeric outer jacket**

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

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

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

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

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

## 7 Mechanical Assembly

7.1 An electrical component shall be securely mounted in place.

7.2 A surface-mounted temperature control shall be:

- a) Secured indirectly to the storage tank by a bracket so as not to be readily displaced, as determined by the Mounting Test of Surface-Mounted Temperature Controls described in Section 31; or
- b) Secured directly to the storage tank by positive fastening means such as screws or stud and nut.

## 8 Accessibility of Live Parts

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

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

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

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

- a) Be an electrical insulating material having a temperature rating of at least 90°C (194°F);
- b) Be at least 1/16 inch (1.6 mm) thick;

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

- c) Extend at least 1/16 inch (1.6 mm) beyond any uninsulated live part (including any uninsulated portion of the conductor); and
- d) Be secured in place by at least two independent means that have been subjected to the barrier pull test described in 32.2. Two parallel or symmetrical tabs are to be identified as two independent means of securement when they project from two different points on the barrier.

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

## 9 Wetting of Live Parts

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

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

## 10 Corrosion Resistance

### 10.1 General

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

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

### 10.2 Storage tanks

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

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

## 11 Electrical Supply Connections – Permanent Connection

### 11.1 General

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

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

*Exception: A small capacity storage tank water heater is not required to be permanently connected when it complies with Electrical Supply Connections– Cord Connection, Section 12.*

## 11.2 Field-wiring compartment

11.2.1 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 11.1. 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 6.1 or 6.2.

**Table 11.1**  
**Minimum volume of field-wiring compartment**

Size of conductor <sup>a</sup>		Free space within compartment for each conductor	
AWG	(mm <sup>2</sup> )	inch <sup>3</sup>	(cm <sup>3</sup> )
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)

<sup>a</sup> For 4 AWG (21.2 mm<sup>2</sup>) or larger conductors, the minimum wire-bending space in Table 11.2 shall be provided.

**Table 11.2**  
**Minimum wire-bending space**

Size of wire		Minimum bending space from connector, lug, knockout, or hole to wall <sup>a</sup>	
AWG	(mm <sup>2</sup> )	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)

<sup>a</sup> When a conductor is restricted from bending by a barrier or otherwise where it leaves the lug, the distance is to be measured from the end of the barrier.

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

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

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

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

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

### 11.3 Field-wiring terminals and leads

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

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

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

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

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

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

- a) A copper supply conductor only; or
- b) An aluminum or a copper supply conductor.

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

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

11.3.7 A wiring terminal shall be prevented from turning.

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

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

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

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

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

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

11.3.12 A wire-binding screw shall thread into metal.

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

## **12 Electrical Supply Connections – Cord Connection**

### **12.1 Power supply cords**

12.1.1 With respect to the Exception of 11.1.2, 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).

12.1.2 An attachment plug provided on a small capacity storage tank water heater shall be of the grounding type and shall be rated in accordance with Table 12.1.

**Table 12.1**  
**Attachment plug rating and supply cord size**

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

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

## 12.2 Bushings

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

- a) There shall be a bushing or equivalent that is secured in place; or
- b) The opening shall have a smooth, rounded surface against which the cord bears.

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

## 12.3 Strain relief

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

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

- a) Subjects the cord to mechanical damage;
- b) Exposes the cord to a temperature higher than that for which it is rated; or
- c) Reduces spacings to values below the minimum values specified in Table 13.1.

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

12.3.2 effective April 29, 2005

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

## 13 Electrical Spacings

### 13.1 General

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

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

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

- a) *The heater is rated 250 volts or less; and*
- b) *The points in question are at other than wiring terminals.*

**Table 13.1**  
**Minimum electrical spacings**

Location in water heater	Rated voltage	Minimum spacing			
		Through air		Over surface	
		inch	(mm)	inch	(mm)
Between uninsulated live parts of opposite polarity and between uninsulated live parts and dead metal parts	250 or less	1/16	(1.6)	1/16	(1.6)
	More than 250	1/4	(6.4)	1/4	(6.4)
At wiring terminals, and not connecting straps or busses extending from such terminals, between:	250 or less	1/2	(12.7)	1/2	(12.7)
	250 or less	1/4	(6.4)	3/8	(9.5)

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

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

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

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

### 13.2 Reduction of spacings due to turning or shifting

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

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

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

## 14 Grounding

### 14.1 General

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

- a) To the enclosure at the point of connection of the wiring system; and
- b) To the equipment-grounding terminal or lead.

*Exception: The requirement for grounding does not apply to:*

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

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

*2) Positively separated from all electrical components.*

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

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

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

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

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

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

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

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

**Table 14.1**  
**Grounding/bonding conductor size**

Maximum rating or setting of automatic overcurrent device in circuit amperes <sup>a</sup>	Size of grounding/bonding conductor <sup>b</sup>			
	Copper wire		Aluminum wire	
	AWG	(mm <sup>2</sup> )	AWG	(mm <sup>2</sup> )
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30 – 50	10	(5.3)	8	(8.4)

<sup>a</sup> The grounding conductor in the cord for a cord connected supply shall be the same or greater size as the current-carrying conductors.

<sup>b</sup> Or equivalent cross-sectional area.

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

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

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

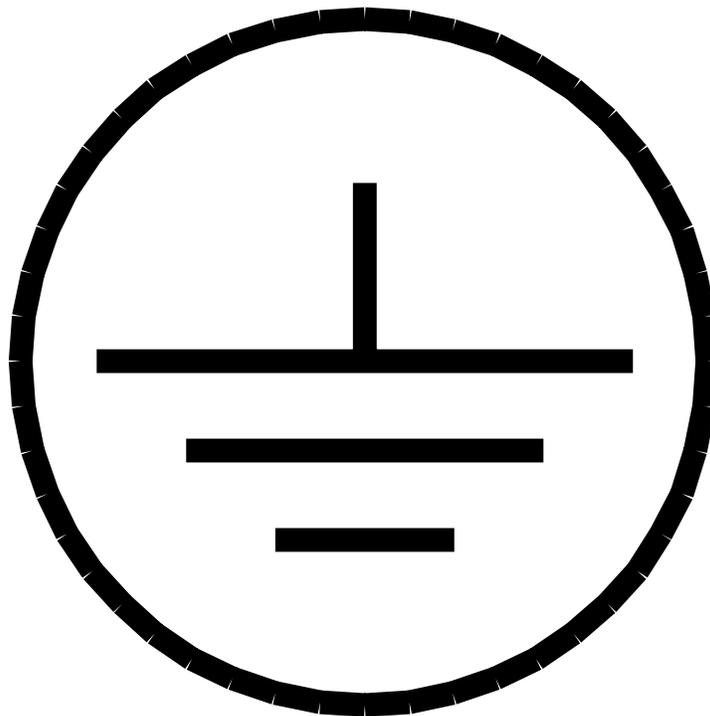
- b) When the top is in place, electrical components contact it under conditions of distortion that are encountered in service.

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

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

- a) Use of a green colored head that is hexagonal shaped or slotted, or both; or
- b) The grounding symbol illustrated in Figure 14.1 on or adjacent to the terminal or on a wiring diagram provided on the product.

**Figure 14.1**  
**Grounding symbol**



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

- a) Being marked "G," "GR," "GND," "Ground," "Grounding," or the like;
- b) A marking on a wiring diagram provided on the water heater; or
- c) The grounding symbol illustrated in Figure 14.1 on or adjacent to the terminal or on a wiring diagram provided on the product.

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

## **14.2 Conductor identification**

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

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

## **15 Reduction of Risk of Injury**

### **15.1 Sharp edges**

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

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

### **15.2 Stability**

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

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

### 15.3 Surface temperatures

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

### 16 Overcurrent Protection

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

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

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

### 17 Materials in Contact with Water

#### 17.1 General

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

#### 17.2 Dip tubes

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

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

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

### 17.3 Polymeric storage tank liner

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

### 18 Current-Carrying Parts

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

18.2 Stainless steel and other corrosion-resistant alloys used for current-carrying parts in a water heater have no restriction as to temperature. Plated iron or steel is capable of being used for current-carrying parts when the material is subjected to a temperature higher than 100°C (212°F), and unplated iron or steel shall not be used.

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

### 19 Internal Wiring

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

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

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

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

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

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

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

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

## 20 Electrical Insulation

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

20.2 Electrical insulating material employed in a heater is to be judged with respect to its intended use. Materials such as mica, some molded compounds, and certain refractory materials are usually intended for use as the sole support of uninsulated live parts. Certain other materials that are not intended for general use, such as magnesium oxide, shall be used only in conjunction with other insulating materials rated for use or when located and protected so that mechanical injury and the absorption of moisture do not occur. When an investigation is required to determine the acceptability of a material, consideration is to be given to mechanical strength of the material, its dielectric characteristics, insulation resistance, heat-resistant characteristics, the degree to which it is enclosed or protected, and any other features that affects the risk of fire, electric shock, or injury to persons in conjunction with the conditions of actual service.

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

## 21 Thermal Insulation

### 21.1 General

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

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

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

## 21.2 Polymeric foam

21.2.1 When polymeric foam is used as thermal insulation:

- a) The foam shall be completely enclosed by sheet-metal having a thickness as indicated in Table 6.1 or by a polymeric outer jacket that complies with 6.3.2;
- b) All enclosure fastening means shall be mechanically secured;
- c) The foam shall not be in contact with the internal wiring of the water heater;
- d) The foam shall be located no less than 2 inches (50.8 mm) from any electrical component, such as a thermostat or heating element; and
- e) The foam shall be rated for the temperatures involved as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

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

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

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

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

- a) The foam has a flame class rating of HF-1 or HF-2 in accordance with the Appendix A included with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; or*
- b) No fire occurs as a result of the electrical disturbance test described in Electrical Disturbance Test of Foam Thermal Insulation, Section 39.*

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

## 22 Heating Elements

### 22.1 General

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

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

### 22.2 Sheathed elements

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

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

## 23 Temperature-Regulating Controls

23.1 A heater having a tank that is not open to the atmosphere shall be subjected to the water temperature test specified in 29.1. The heater complies when the thermostat that controls each heating element limits the water temperature to 85°C (185°F) or less.

23.2 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.

23.3 A temperature-regulating thermostat or control shall be set before leaving the factory to a control position corresponding to a temperature no higher than 51.7°C (125°F).

## 24 Temperature-Limiting Controls

24.1 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 29.2 regardless of the position of the actuating handle or button lever (that is, the control is "trip free"); and
- e) Does not automatically reclose at temperatures above 0°C (32°F).

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

24.3 The temperature-limiting control shall have no operating part in common with the temperature-regulating thermostat specified in 23.1, and a common mounting bracket or a common enclosure is capable of being employed for both types of control.

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

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

## 25 Storage Tank

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

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

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

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

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

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

- a) Shall be located:
  - 1) In the top of the tank; or
  - 2) With its center line in the upper 6 inches (152 mm) of the side.
- b) Shall be separate from the openings for water connections.
- c) Shall be threaded in conformity with the requirements for Pipe Threads, ANSI B2.1.
- d) Shall accommodate a 1/2 inch (12.7 mm) or larger trade-size pipe when the rating is less than 4.5 kilowatts, and shall accommodate a 3/4 inch (19.1 mm) or larger trade size pipe when the rating is 4.5 kilowatts or more.

## PERFORMANCE

### 26 Power Input Test

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

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

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

- a) For a heater rated 120 volts or less, or with a range of voltages (such as 105 – 110 volts) where no voltage within the range exceeds 120 volts, the test voltage is to be 120 volts.
- b) For a heater with a single voltage rating that exceeds 120 volts, the test is to be conducted at the rated voltage. When the single voltage rating falls within the range of 220 – 240, 254 – 277, or 440 – 480 volts, the test is to be conducted at the maximum voltage in the particular range.
- c) For a heater with a range of voltages, any part of which exceeds 120 volts, the test is to be conducted at the highest voltage of the rated range.

### 27 Insulation Resistance Test

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

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

### 28 Temperature Test

#### 28.1 General

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

## 28.2 Maximum load

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

**Table 28.1**  
**Maximum temperature rises**

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

<sup>a</sup> A fuse that has been investigated and found intended for use at a higher temperature shall be used at that temperature.

<sup>b</sup> The limitation on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and determined to have special heat-resistant properties.

<sup>c</sup> Inside a water heater, the temperature rise on a wire or cord shall be greater than the specified maximum rise when the insulation on each individual conductor is protected by supplementary insulation, such as braid, wrap, tape, or close-fitting tubing that is rated for the temperature and type of insulation provided.

<sup>d</sup> It is to be assumed that field installed conductors or splices are capable of touching the tank or other parts located in or back of the terminal box or compartment even though such components are covered with thermal insulation.

<sup>e</sup> Unless the material is thermal-setting, the maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined by the Test Method for Softening Point by Ring-and-Ball Apparatus, ASTM E28.

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

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

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

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

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

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

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

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

### 28.3 Surface temperatures

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

**Table 28.2**  
**Maximum surface temperatures**

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

NOTE – All temperature limits are based on 25°C (77°F) ambient temperature.  
<sup>a</sup> Includes plastic with a metal plating no more than 0.005 inch (0.13 mm) thick; and metal with a plastic or vinyl covering no less than 0.005 inch thick.

### 28.4 Dry operation

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

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

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

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

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

## 29 Water Temperature Test

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

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

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

- a) When the thermostat directly controls the heating load current:
  - 1) The thermostat is to be short-circuited in a heater incorporating only one thermostat.
  - 2) Two thermostats are to be short-circuited simultaneously in a heater incorporating two or more thermostats. The limiting control is to remain functional and in the circuit; and
- b) When the thermostats control the coil of a magnetic contactor, only one thermostat is to be short-circuited at a time, regardless of the total number of temperature-regulating thermostats provided.

## 30 Dielectric Voltage-Withstand Test

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

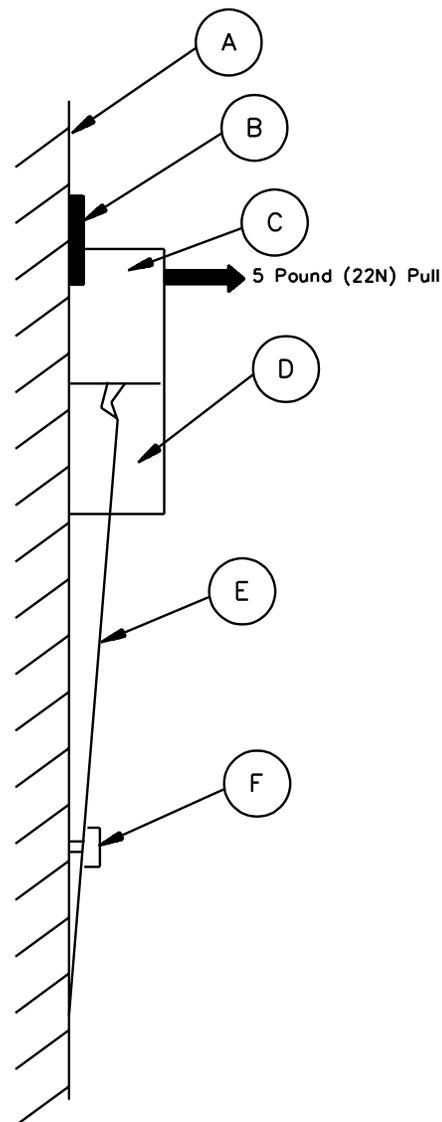
30.2 To determine compliance with 30.1, the heater is to be tested by means of a 500 volt-ampere or larger capacity testing transformer, the output voltage of which varies. Starting at zero, the applied potential is to be increased until the required test value is reached and to be held at that value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

## **31 Mounting Test of Surface-Mounted Temperature Controls**

### **31.1 Horizontal pull**

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

**Figure 31.1**  
**Example of test of temperature control mounting means**



S2193

- 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

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

### 31.2 Supply lead pull

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

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

### 32 Barrier Pull Tests

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

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

### 33 Water Capacity Test

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

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

### 34 Grounding-Circuit Resistance Measurement Test

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

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

### 35 Storage Tank Hydrostatic Pressure Test

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

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

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

### 36 Nonmetallic Dip Tube Tests

#### 36.1 Deformation of weight loss

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

- a) Have a linear deformation not in excess of 1/2 inch (12.7 mm);
- b) Have a total lateral deformation not in excess of 1-1/2 inches (38.1 mm); and
- c) Undergo no weight loss.

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

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

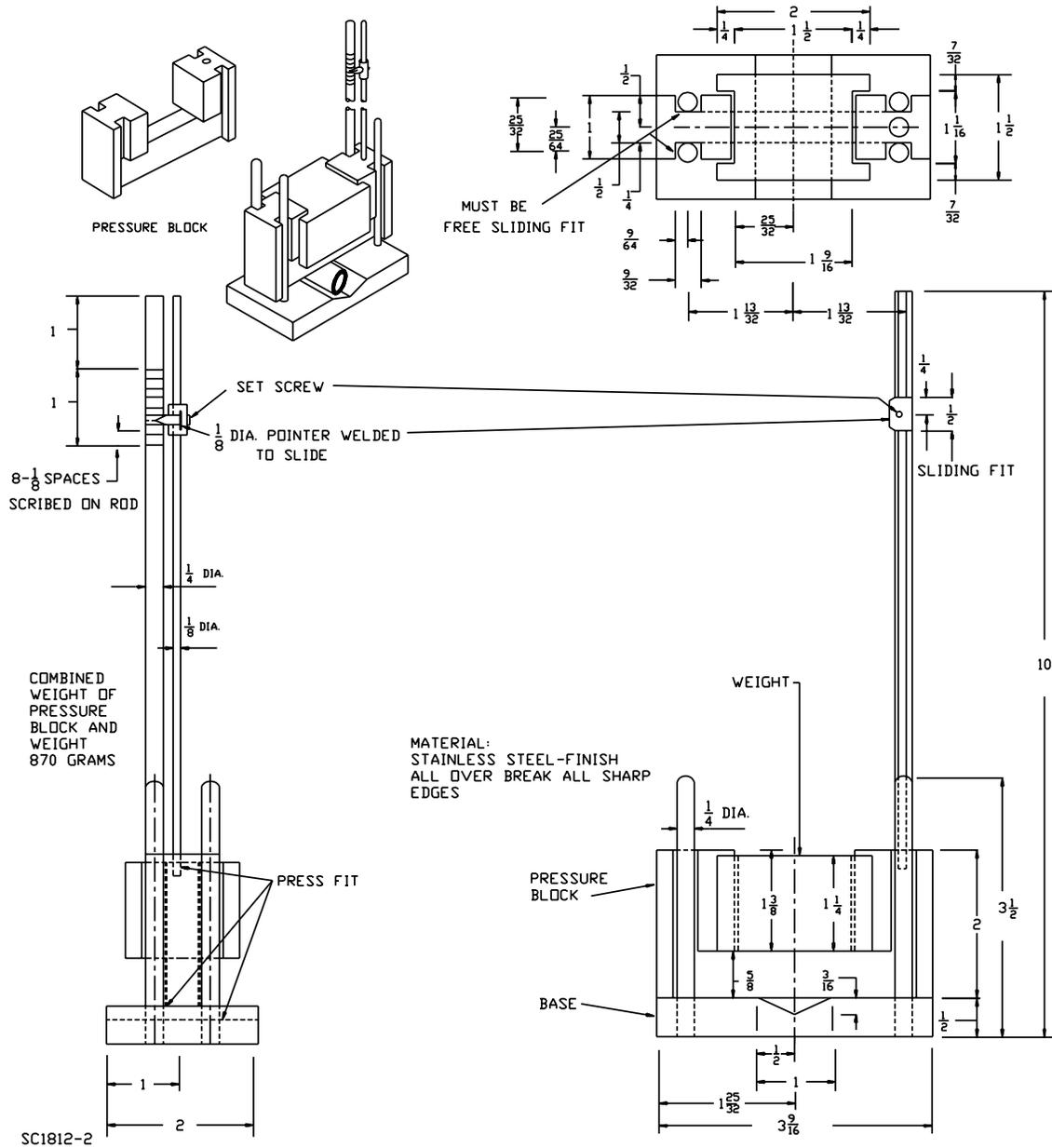
36.1.4 Lateral deformation is to be determined by installing one end of each sample in a fixture (as it is by a tank inlet fixture) and measuring the distance between the position of the center line of the free end and the extended center line of the fixture. Following immersion for 48 hours in water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

## 36.2 Resistance to crushing

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

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

**Figure 36.1**  
**Heat deformation tester**



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)

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

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

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

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

### 36.3 Collapse

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

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

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

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

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

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

### **37 Strain Relief Test**

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

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

### **38 Push Back Relief Test**

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

38.1 effective April 29, 2005

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

38.2 effective April 29, 2005

### **39 Electrical Disturbance Test of Foam Thermal Insulation**

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

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

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

**Table 39.1**  
**Electrical disturbance test conditions**

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

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

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

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

#### **40 Leakage Current Test**

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

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

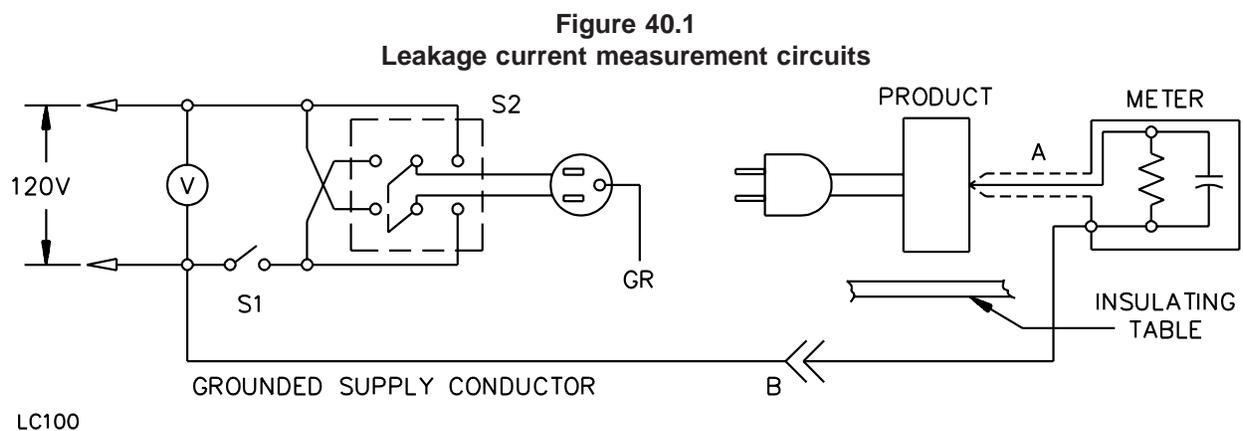
40.3 All exposed conductive surfaces are to be tested for leakage current. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively when simultaneously accessible, and from one such surface to another when simultaneously accessible.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

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

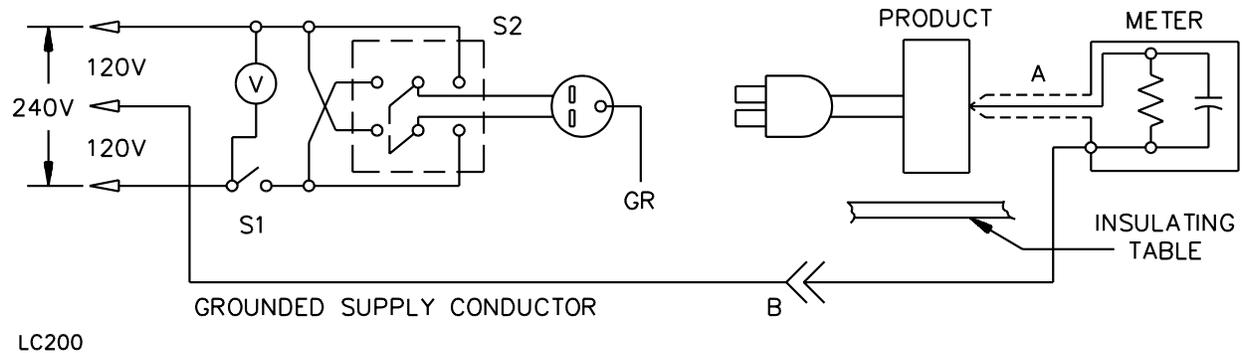
*Exception: For an enclosure surface smaller than 3.94 by 7.87 inches (100 by 200 mm), the piece of metal foil is to be the same size as the surface.*

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

- a) The defined meter has an input impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor.
- b) The defined meter indicates 1.11 times the average of the full wave rectified composite waveform of the voltage across or current through the resistor.
- c) The defined meter, over a frequency range of 0 – 100 kilohertz, has a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to a 1500 ohm resistor. At an indication of 0.75 milliampere, the measurement is to have an error of no more than 5 percent at 60 hertz.
- d) Unless the meter is being used to measure leakage from one part of an appliance to another, it is to be connected between the accessible parts and the grounded supply conductor.



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.

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

- a) With switch S1 open, the appliance is to be connected to the measurement circuit, and the leakage current is to be measured using both positions of switch S2 with the appliance switching device in all intended operating positions.
- b) Switch S1 is then to be closed, energizing the appliance, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2 with the appliance switching device in all intended positions.
- c) The leakage current is to be monitored until thermal stabilization has been attained. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation of the appliance as in the temperature test.

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

## 41 Enclosure Strength Test

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

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

## 42 Permanence of Markings

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

- a) Etched;
- b) Molded;
- c) Die stamped;
- d) Paint stenciled;
- e) Permanently secured, stamped or etched metal; or
- f) Indelibly stamped lettering on pressure sensitive labels secured by adhesive.

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

## MANUFACTURING AND PRODUCTION TEST

### 43 Production Line Dielectric Voltage-Withstand Test

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

- a) Between the primary wiring, including connected components, and accessible dead metal parts that become energized; and
- b) Between primary wiring and accessible low voltage (42.4 volts peak or less) metal parts, including terminals.

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

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

**Table 43.1**  
**Production line test conditions**

Appliance rating, volts	Condition A		Condition B	
	volts	seconds	volts	seconds
250 or less	1200	1	1000	60
More than 250	1200 + 2.4V <sup>a</sup>	1	1000 + 2V <sup>a</sup>	60

<sup>a</sup> V is the maximum marked voltage, and no less than 240 volts.

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

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

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

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

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

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

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

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

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

- a) By a voltmeter in the primary circuit or in a tertiary winding circuit;
- b) By a selector switch marked to indicate the test potential; or
- c) In the case of equipment having a single test potential output, by a marking in a readily visible location to indicate the test potential.

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

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

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

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

- a) With a single pole primary switch, when used, in the off position; or*
- b) With only one side of the primary circuit connected to the test equipment when the primary switch is in the on position or when a primary switch is not used.*

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

## RATINGS

### 44 Electrical

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

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

### 45 Tank Pressure and Capacity

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

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

## MARKINGS

### 46 Identification

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

- a) The manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product is identified;
- b) The date or other dating period of manufacture not exceeding any three consecutive months, which is abbreviated or in a nationally accepted conventional code, or a code affirmed by the manufacturer;
- c) A distinctive catalog or model number or the equivalent; and
- d) The electrical rating.

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

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

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

- a) A nonmetallic dip tube;
- b) A nonmetallic heat trap tube; or
- c) A nonmetallic inlet water deflector.

## 47 Ratings

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

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

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

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

- a) Its electrical ratings in amperes or watts, and volts; or
- b) The manufacturer's part number.

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

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

## 48 Warning Notices

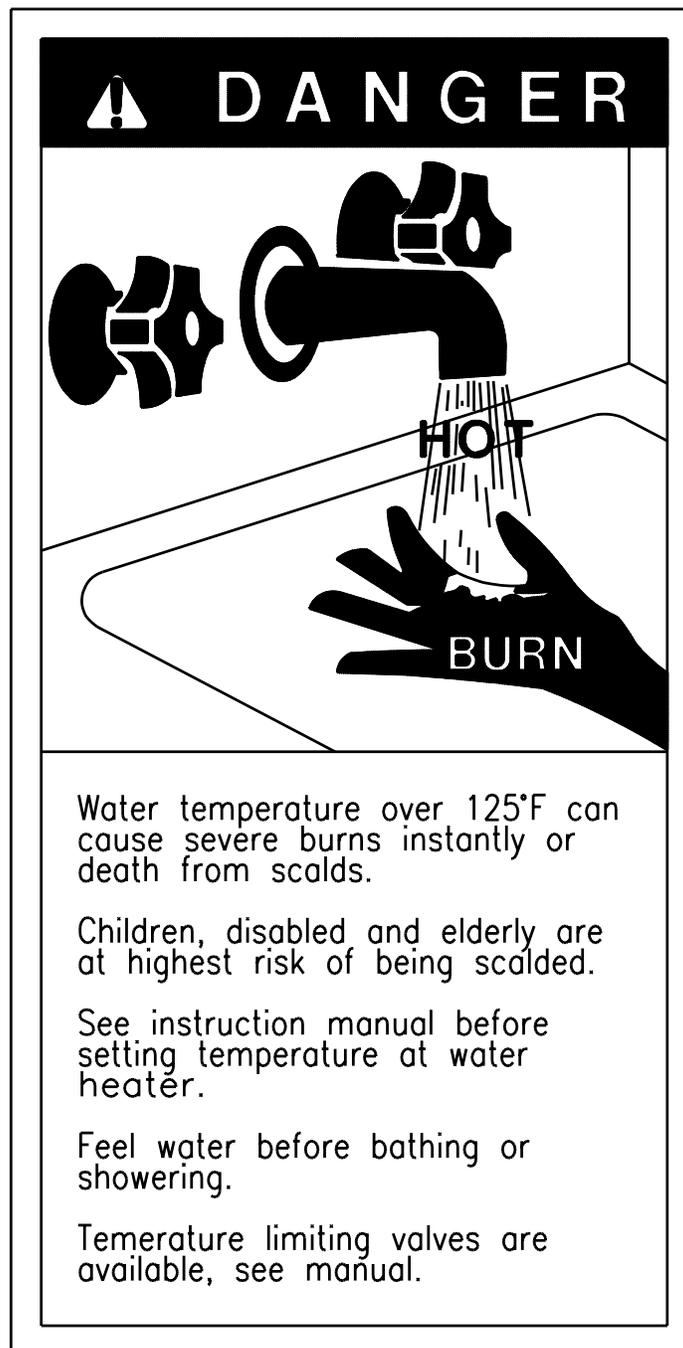
48.1 When the temperature-limiting control must be replaced after it has performed its intended function, the water heater shall be permanently marked with the word "DANGER" and the following or the equivalent: "To reduce the risk of electric shock disconnect from power supply before replacing temperature-limiting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

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

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

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

Figure 48.1  
Example of scald or burn marking for a water heater with an adjustable temperature-regulating control



SM428

(Figure 48.1 is copyrighted by the American Gas Association. Used by permission of the copyright holder.)

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

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

- a) The text of the label shall be located below (vertical arrangement) or to the right of (horizontal arrangement) the graphic illustration. The minimum label sizes are as follows:
  - i) Vertical: 3 1/4 inches x 6 1/4 inches (82.6 mm x 158 mm); and
  - ii) Horizontal: 6 inches x 3 1/4 inches (152 mm x 82.6 mm).
- b) The label shall be boxed by a 1/4 inch (6.4 mm) border. A 3/8 inch (9.8 mm) red bar shall be at the top of the label, within the border. A red on white international symbol for caution shall be located on the red bar followed by the word "DANGER" in white boldfaced letters having a minimum letter height of 0.240 inches (6.4 mm).
- c) The graphic illustrations for the faucet, knobs, bathtub outline, spraying water, and hand shall be black on a white background. The water spattered on the hand shall be in red.
- d) The word "HOT" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.180 inches (4.6 mm).
- e) The word "BURN" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.140 inches (3.56 mm).
- f) All text below the illustration shall be either black boldfaced letters on white background or white boldfaced letters on black background. The letters shall have a minimum uppercase letter height of 0.120 inches (3.05 mm). Lowercase letters shall be compatible with the uppercase letter size specifications.

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

- a) The text of the label shall be located below the graphic illustration. The minimum label size shall be vertical: 2 1/8 inches x 4 1/8 inches (54 mm x 105 mm).
- b) The label shall be boxed by a 1/8 inch (3.2 mm) border. A 1/4 inch (6.4 mm) red bar shall be at the top of the label, within the border. A red on white international symbol for caution shall be located on the red bar followed by the word "DANGER" in white boldfaced letters having a minimum letter height of 0.140 inches (3.56 mm).
- c) The graphic illustrations for the faucet, knobs, bathtub outline, spraying water and hand shall be black on a white background. The water spattered on the hand shall be in red.
- d) The word "HOT" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.120 inches (3.05 mm).
- e) The word "BURN" shall be in red boldfaced letters. The letters shall be a minimum letter height of 0.120 inches (3.05 mm).
- f) All text below the illustration shall be either black boldfaced letters on white background or white boldfaced letters on black background. The letters shall have a minimum uppercase letter height of 0.070 inches (1.78 mm). Lowercase letters shall be compatible with the uppercase letter size specifications.

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

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

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

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

## 49 Informational Markings

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

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

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

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

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

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

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

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

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

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

Revised 49.9 effective November 4, 2006

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

Added 49.10 effective November 4, 2006

## INSTRUCTIONS

### 50 General

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

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

- a) Inform the user that the thermostat has been set at the factory to 51.7°C (125°F) or lower to reduce the risk of scald injury;
- b) Inform the user how to change this setting when the user so desires;
- c) Include any precautions to be followed in changing the setting; and
- d) Provide information regarding the availability of temperature-limiting valves for use in hot water lines.

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

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

50.5 The instructions shall specify that when a water heater is installed in a closed water-supply system, such as one having a back-flow preventer in the cold-water supply, means shall be provided to control thermal expansion. Contact the water supplier or local plumbing inspector for information regarding the control of this situation.

## 51 Safety Instructions

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

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

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

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

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

### IMPORTANT SAFETY INSTRUCTIONS

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

1. READ ALL INSTRUCTIONS BEFORE USING THIS WATER HEATER.
2. This water heater must be grounded. Connect only to properly grounded outlet. See "GROUNDING INSTRUCTIONS" found on (specific page or section to be included).
3. Install or locate this water heater only in accordance with the provided installation instructions.

**UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL**

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**

*UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL*

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

## SUPPLEMENT SA - 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, ANSI/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:

- a) A flammable hydrocarbon mixture surrounding the water heater is not ignited when a normally occurring electrical arc, spark, or heat source ignites a flammable hydrocarbon mixture inside the electrical controls;
- b) The electrical arc, spark, or heat source does not have required electrical or heat energy to ignite the flammable mixture; or
- c) 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.

## 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 risk 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:

- a) The vibration and shock encountered in the application without malfunction of the mounting means, electrical connections, or storage tank;
- b) The reduction in electrical spacings to less than the minimum required values; or
- c) The defeat of the ignition-protected feature (when 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 is not required to comply with this requirement.*

SA3.4 When a water heater also employs a heat exchanger using engine coolant liquid as the heating medium, tubing used in the heat exchanger shall be of double-wall construction. The interface between tubes shall be vented to the atmosphere in a location that any leakage of coolant is detected.

### SA4 Electrical Supply Connections

SA4.1 Flexible cord shall either 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 intended 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 rated for extra-hard service (Type ST, SO, or the equivalent) is not required to be less 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 intended for a marine environment in accordance with Table 8-14.4 of the Fire Protection Standard for Pleasure and Commercial Motor Craft, NFPA 302.

## SA6 Temperature-Limiting Controls

SA6.1 With respect to 22.1(c), the temperature-limiting means of the heater shall be of the manually reset type unless the control:

- a) Does not reclose at temperatures above minus 35°C (minus 31°F); and
- b) Is not of the replaceable element type.

## PERFORMANCE

### SA7 Vibration Test

SA7.1 A water heater shall withstand 12 hours of vibration without:

- a) Leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons;
- b) Reduction of electrical spacings to less than minimum rated values; or
- c) Defeat of the ignition-protected feature as described in SA9.1. Following the conditioning described in 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 24.1.

*Exception: A product marked in accordance with the requirement in SA11.1 is not required to 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. When 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 rectilinear 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  $0.020 \pm 0.002$  inch ( $0.51 \pm 0.05$  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:

- a) Leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons;
- b) Reduction of spacings to less than the minimum rated values; or
- c) Defeat of the ignition-protected feature as described in SA9.1. Following the conditioning described in 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 24.1.

*Exception: A product marked in accordance with the requirement in SA11.1 is not required to 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 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<sup>2</sup>)] 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 SA11.2 and SA11.3.

SA9.2 For a water heater not marked as specified in SA11.2 Only a water heater that complies with the Ignition Protection Test described in Section SA9 shall be marked "Ignition Protected".

**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 connection 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 is stressed from any angle that the construction permits. The strain relief does not comply when, at the point at which the conductors of the cord are disconnected, there is movement of the cord to indicate that stress is transmitted to connections.

**MARKING****SA11 Identification**

SA11.1 A water heater not shown to comply with the requirements of the Vibration Test described in Sections 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 complies with the Ignition Protection Test described in Section SA9 shall be marked "Ignition Protected".

SA11.3 A water heater that does not comply with 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".

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

## APPENDIX A

### Standards for Components

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

Title of Standard – UL Standard Designation

---

Attachment Plugs and Receptacles – UL 498  
Fittings for Cable and Conduit – 514B  
Flexible Cord and Fixture Wire – UL 62  
Fuseholders – UL 512  
Fuses - Part 7: Class H Renewable, Low-Voltage – UL 248-7  
Fuses - Part 9: Class K, Low-Voltage – UL 248-9  
Fuses - Part 11: Plug Fuses, Low-Voltage – UL 248-11  
Fuses-Part 12: Class R Fuses, Low-Voltage – UL 248-12  
Fuses - Part 14: Supplemental Fuses, Low-Voltage – UL 248-14  
Fuses - Part 15: Class T Fuses, Low-Voltage – UL 248-15  
Fuses - Part 16: Test Limiters, Low-Voltage – UL 248-16  
Heating Elements, Sheathed – UL 1030  
Marking and Labeling Systems – UL 969  
Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures – UL 489  
Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers – UL 514C  
Outlet Boxes, Metallic – UL 514A  
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 – UL 873  
Terminal Blocks – UL 1059  
Terminals, Electrical Quick-Connect – UL 310  
Thermal-Links – Requirements and Application Guide – UL 60691  
Wire Connectors – UL 486A-486B  
Wire Connectors, Splicing – UL 486C  
Wires and Cables, Thermoplastic-Insulated – UL 83

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***

**Superseded requirements for  
the Standard for  
Household Electric Storage Tank Water Heaters**

**UL 174, Eleventh Edition**

The requirements shown are the current requirements that have been superseded by requirements in this edition. The numbers in parentheses refer to the new requirements with future effective dates that have superseded these requirements. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

10.3.2 (12.3.2) Means shall be provided to prevent the power supply cord from being pushed into the enclosure of a water heater through the cord entry hole when such displacement:

- a) Subjects the cord to mechanical damage;
- b) Exposes the cord to a temperature higher than that for which it is rated; or
- c) Reduces spacings to values below the minimum values specified in Table 11.1.

49.9 A water heater shall be marked "when water heater is equipped with supplemental heat the supplemental heat shall be controlled by the thermostat and limit control on the Certified Household Electric Storage Tank Water Heater". (An example of supplemental heat is a refrigeration loop off of the condensing unit of an air conditioning system).

49.9 effective April 29, 2005

No Text on This Page

***UL COPYRIGHTED MATERIAL –  
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR  
DISTRIBUTION WITHOUT PERMISSION FROM UL***