

UL 1453

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Electric Booster and Commercial Storage Tank Water Heaters

Underwriters Laboratories Inc. (UL)
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for
Electric Booster and Commercial Storage Tank Water Heaters, UL 1453

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Revisions: This Standard contains revisions through and including September 29, 1998. UL is in the process of converting its Standards for Safety to 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 the page. Significant benefits that will result from UL's use of SGML are increased productivity, reduced turnaround times, and data and information consistency, reusability, shareability, and portability. The changes noted in these revised pages are needed to modify the format and layout of this Standard to allow it to be converted to SGML. These editorial changes are now in effect.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The new and/or revised requirements are substantially in accordance with UL's Bulletin on this subject dated July 2, 1998. The bulletin is now obsolete and may be discarded.

The revisions dated September 29, 1998 include a reprinted title page (page 1) for this Standard.

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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.

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Standards for Components A1

FOREWORD

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

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

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

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

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

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

INTRODUCTION

1 Scope

1.1 These requirements cover electric booster water heaters, electric commercial storage tank water heaters, and remote control assemblies for such heaters, rated 600 volts or less, to be employed in ordinary locations in accordance with the National Electrical Code, NFPA 70, and that meet at least one of the following conditions:

- a) Over 120 gallons (454 L) in capacity;
- b) Rated over 12 kilowatts; or
- c) Equipped with one or more temperature-regulating controls that permit a water temperature of more than 85EC (185EF).

1.2 These heaters are intended for installation in accordance with model mechanical and plumbing codes.

1.2 revised June 23, 1997

1.3 An electric water heater not exceeding 120 gallons (454 L) capacity, rated no more than 12 kilowatts, and equipped with a temperature-regulating thermostat having no marked dial setting more than 77EC (171EF) and provided with a stop to prevent adjustment to a higher setting, shall be judged in accordance with the requirements in the Standard for Household Electric Storage-Tank Water Heaters, UL 174.

1.4 These requirements do not cover electric boilers, commercial cooking appliances, medical and dental equipment, or other electric heating equipment or appliances that are covered in or as part of individual requirements that are separate from this standard. Electrode type boilers are not covered by these requirements.

1.5 In the following text, a requirement that applies only to booster water heaters or to commercial storage-tank water heaters is so identified by a specific reference in that requirement to the equipment involved. Absence of such a specific reference or use of the term water heater indicates that the requirement applies to all of the equipment covered in this standard unless the context indicates otherwise.

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

2 General

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

2.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are root mean square (rms).

3 Glossary

3.1 For the purpose of this standard the following definitions shall apply.

3.2 **BOOSTER WATER HEATER** – A water heater furnishing hot water from initially heated water, which is usually 60EC (140EF), with the minimum output water temperature being 77EC (171EF).

3.3 **ELECTRICAL CIRCUITS** –

a) **Line Voltage Circuit** – A circuit involving a potential of no more than 600 volts and having circuit characteristics in excess of those of a low voltage circuit.

b) **Low Voltage Circuit** – A circuit involving a potential of no more than 30 volts rms (42.4 volts peak) supplied by a battery or by a standard Class 2 transformer or other transforming device, or by a combination of transformer and fixed impedance having output characteristics in compliance with requirements established for a Class 2 transformer. A circuit obtained by connecting resistance in series with a line voltage supply circuit as a means of limiting the voltage and current is not considered to be a low voltage circuit.

3.4 **HEATING ELEMENT ACCESSORY** – An attachment to the water heater that will allow electrical rating modification. The heating element accessory consists of a heating element(s), a new rating label, and associated hardware to mount the element(s).

3.5 **QUALIFIED SERVICE PERSONNEL** – Persons having appropriate technical training and experience necessary to:

a) Perform tasks in **SERVICE ACCESS AREAS** of the equipment; and

b) Be aware of hazards to which they are exposed in performing a task, and of measures to minimize the danger to themselves or other persons.

3.6 **SAFETY CONTROL** – A control that is relied upon to reduce the risk of fire, electric shock, or injury to persons – for example, an interlock. A safety control may include such devices as relays, switches, interlocks, and other auxiliary equipment used to form a safety control system.

3.7 **TEMPERATURE-PRESSURE RELIEF VALVE** – An automatic resetting pressure relieving device actuated by water pressure or an integral thermal element that is in contact with and responsive to the heated water.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.2 A component need not comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

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

4.4 Specific components are recognized as being 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 for which they have been recognized.

CONSTRUCTION

5 Frame and Enclosure

5.1 General

5.1.1 A water heater shall be provided with an enclosure housing all parts that may present a risk of fire, electric shock, or injury to persons under any condition of use.

5.1.2 The frame and enclosure of a water heater shall have strength and rigidity to resist the abuses likely to be encountered during intended use. The degree of resistance inherent in the water heater 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.

5.1.3 An enclosure for individual electrical components, an outer enclosure, and combinations of the two shall be considered in determining compliance with the requirements in this section.

5.1.4 An enclosure shall be reinforced or formed so that it is not likely to be damaged through handling in shipment, installation and use.

5.2 Enclosure materials

5.2.1 Among the factors to be taken into consideration when an enclosure is judged for acceptability are its:

- a) Physical strength;
- b) Resistance to impact;
- c) Moisture absorptive properties;
- d) Combustibility;
- e) Resistance to corrosion; and
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under all conditions for use.

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

5.2.2 An outer cabinet is judged with respect to the size, shape, and thickness of metal in accordance with 5.2.3.

5.2.3 The minimum thickness of sheet metal that serves as an electrical enclosure shall be as specified in Table 5.1 or 5.2.

Exception: An enclosure thinner than specified in Table 5.1 or 5.2 may be employed, as described in 5.2.4 and 5.2.5 if:

- a) The location of the enclosure meets the criteria described in 5.1.2;*
- b) The construction and location of components meet the criteria described in 5.1.2; or*
- c) The strength and rigidity of the frame and enclosure meet the criteria described in Section 44, Enclosure Strength Test.*

5.2.4 Unless thinner sheet metal would be acceptable in accordance with Table 5.1 or 5.2, a sheet metal enclosure that, in accordance with Exception(a) of 5.2.3, is not likely to be subjected to damage shall be made of uncoated steel at least 0.026 inch (0.66 mm) thick, of galvanized steel at least 0.029 inch (0.74 mm) thick, or of aluminum, copper, or brass at least 0.036 inch (0.91 mm) thick.

5.2.5 With reference to Exception(b) of 5.2.3, the minimum thickness of an enclosure may be less than specified in Table 5.1 or 5.2 for the size enclosure as indicated below. The thickness shall be no less than 0.026 inch (0.66 mm) if uncoated steel, 0.029 inch (0.74 mm) if coated steel, or 0.036 inch (0.91 mm) if aluminum, copper, or brass unless a lesser thickness would be acceptable in accordance with Table 5.1 or 5.2.

- a) If the electrical components are located at least 2-1/2 inches (64 mm) from the enclosure surface, the minimum thickness may be the value indicated in the first line above the normal value.
- b) If the electrical components are located at least 5 inches (127 mm) from the enclosure surface, the minimum thickness may be the value indicated in the second line above the normal value.

Table 5.1
Minimum thickness of sheet metal for enclosures carbon steel or stainless steel

Without supporting frame ^a			With supporting frame or equivalent reinforcing ^a				Minimum thickness, inch (mm)				
Maximum width ^b		Maximum length ^c		Maximum width ^b		Maximum length					
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)				
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020	(0.51)	0.023	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)				
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026	(0.66)	0.029	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)				
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)				
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)				
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)				
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)				
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)				
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.03)	0.084	(2.13)
35.0	(88.9)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)				
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)				
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)				
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)				

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) Single sheet with single formed flanges (formed edges);
- 2) A single sheet that is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified.

Table 5.2
Minimum thickness of sheet metal for enclosures aluminum, copper, or brass

Without supporting frame ^a				With supporting frame or equivalent reinforcing ^a				Minimum thickness
Maximum width ^b		Maximum length ^c		Maximum width ^b		Maximum length		Inch
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	(mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)	(0.58)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)	(0.74)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)	(0.91)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	(1.14)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	(1.47)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075
20.0	(50.8)	25.0	(63.5)	45.0	(114.3)	55.0	(139.7)	(1.91)
25.0	(63.5)	Not limited		60.0	(152.4)	Not limited		0.095
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)	(2.41)
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited		0.122
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)	(3.10)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited		0.153
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	160.0	(406.4)	(3.89)

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) Single sheet with single formed flanges (formed edges);
- 2) A single sheet which is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified.

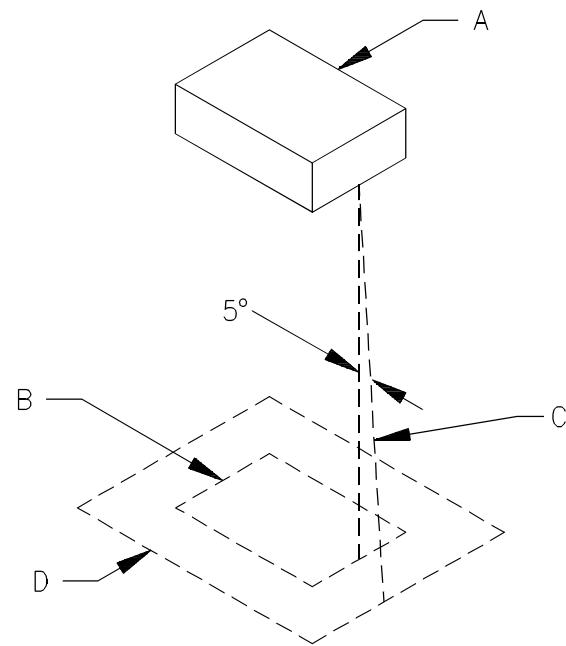
5.3 Reduction of risk of emission of burning particles or molten metal

5.3.1 The enclosure of a water heater shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the water heater is supported.

5.3.2 The requirement in 5.3.1 will necessitate that a switch, a relay, a solenoid, or the like be individually and completely enclosed, other than at terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the water heater enclosure. It will also necessitate the use of a barrier of combustion resistant material under wiring, unless the wiring is insulated with neoprene, asbestos, or thermoplastic.

5.3.3 The barrier mentioned in 5.3.2 shall be horizontal, shall be located as illustrated in Figure 5.1, and shall have an area no less than that described in Figure 5.1. Openings for drainage, ventilation, and the like may be employed in the barrier, provided that such openings would not permit molten metal, burning insulation, or the like to fall on combustible material.

Figure 5.1
Location and extent of barrier



SA0604

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

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. When moving, the line is always tangent to the component, 5 degrees from the vertical, and so oriented that the area traced out on a horizontal plane is maximum.

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

Figure 5.1 revised September 29, 1998

5.4 Accessibility of live parts

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

5.4.2 The enclosure may have an opening that has a minor dimension of less than 1 inch (25.4 mm) if a probe, as illustrated in Figure 5.2, inserted through the opening cannot be made to touch any uninsulated live part or enamel insulated wire that may cause an electric shock. The probe shall be applied in all possible articulated positions before, during, and after insertion.

Figure 5.2
Articulate probe

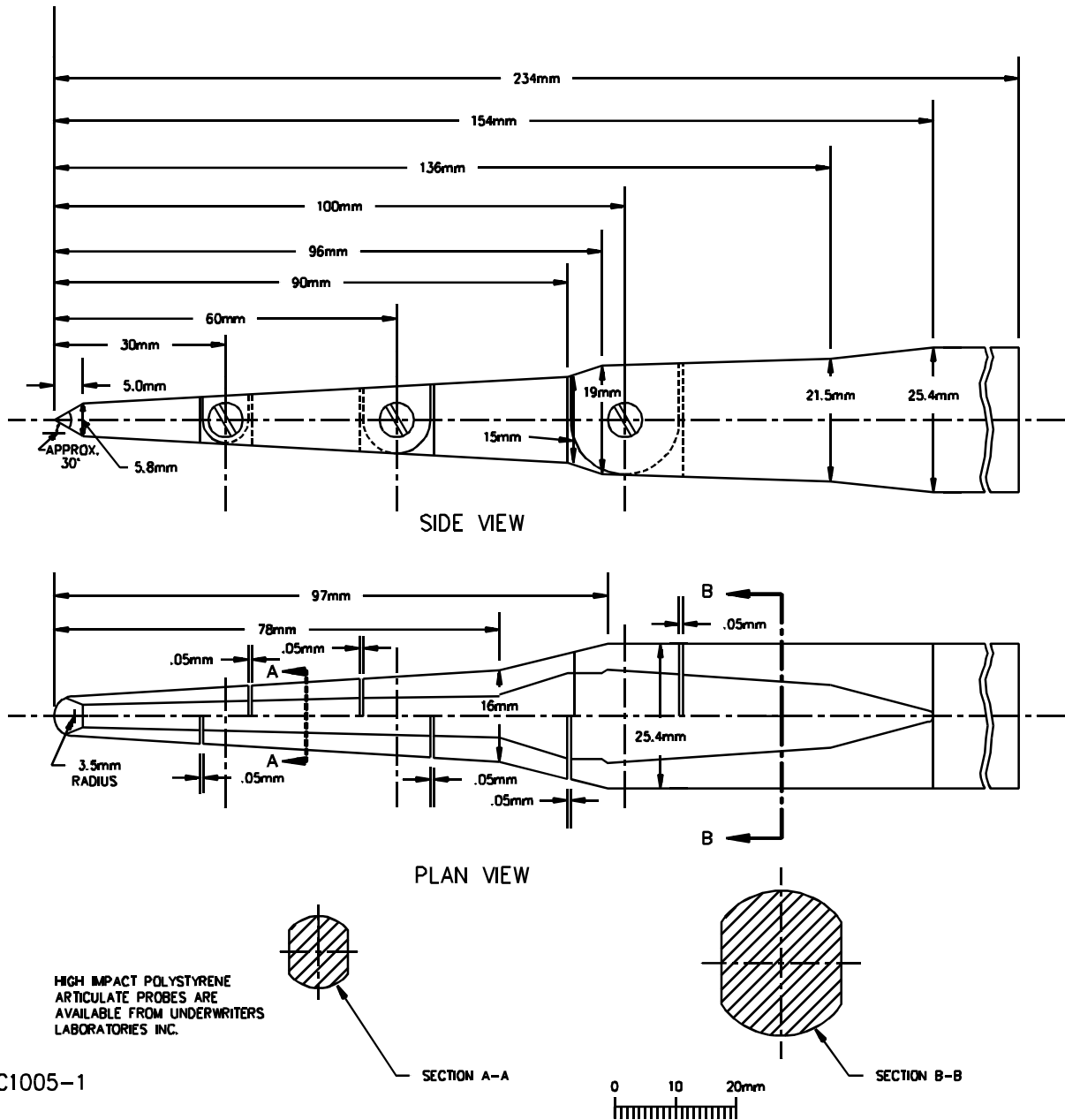


Figure 5.2 revised September 29, 1998

5.4.3 During the examination of a water heater in connection with the requirements in 5.4.1 and 5.4.2, a part of the outer enclosure that may be removed by the user without the use of a tool (to permit the attachment of accessories, to allow access to means for making operating adjustments, or for other reasons) is to be removed. Such a part shall not be considered to provide protection against electric shock or personal injury whether or not the marking specified in 54.8 is provided.

5.4.4 An uninsulated live part located within 6 inches (152 mm) of a control or device that may need to be adjusted shall not be exposed to contact by the user or service personnel adjusting the setting of a temperature-regulating thermostat, operating the resetting mechanism of a temperature-limiting control, operating a water drain valve, or performing a similar operation. This requirement applies even if the unit is marked as indicated in 54.5.

5.5 Ventilation openings

5.5.1 An opening for ventilation in the enclosure of a water heater or in an externally mounted component shall be located so that it will not vent into concealed spaces of a building structure, such as into a false ceiling space, into hollow spaces in the wall, or the like, when the heater is installed as indicated.

Exception: This requirement does not apply to an opening for a mounting screw or nail or for a manufacturing operation, such as paint drainage, if the opening has no dimension larger than 17/64 inch (6.7 mm) or area greater than 0.055 square inch (35.5 mm²).

5.5.2 An opening for ventilation in the enclosure, other than in the bottom, shall be provided with one or more baffles that will prevent the emission of flame, molten metal, burning insulation, or the like from the water heater.

Exception: In a compartment other than one that houses a motor overload relay or overcurrent protective device such as a fuse or circuit breaker, the baffles may be omitted if:

- a) No ventilating opening in a vertical wall is greater than 3/8 inch (9.5 mm) wide; or*
- b) The water heater is constructed so that it is not likely to result in a risk of fire as shown by an investigation including short circuit testing.*

6 Heating Element Accessories

6.1 A water heater having provisions for the use of a heating element accessory intended to be attached in the field shall comply with the requirements in this standard, with or without the accessory installed.

6.2 The installation of a heating element accessory by qualified service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals. A heating element accessory shall not be intended for installation by the user.

6.3 An installation shall not require the cutting of wiring or the soldering of connections by the installer. Installations shall not require cutting, drilling, or welding in electrical enclosures and in other areas where such operation may damage electrical components and wiring within the enclosure.

6.4 A means for strain relief shall be provided for the wiring in the accessory if there is a possibility of transmitting stress to the terminal connections during the installation.

6.5 All terminals and wiring intended to be field connected shall be identified on the accessory, on the water heater if connections are made between the accessory and the water heater, and on the wiring diagram.

6.6 The mounting location of the accessory shall be indicated on the water heater.

Exception: If the mounting location is obvious due to the function of the accessory and arrangement of the water heater, and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory need not be indicated on the water heater.

6.7 As part of the investigation, an accessory is to be trial installed to determine that the installation is feasible, the instructions are detailed and correct, and the use of the accessory does not introduce a risk of fire, electric shock, or injury to persons.

7 Doors and Covers

7.1 A door or a cover of an enclosure shall be provided with a means for holding it securely in place in the closed position.

7.2 A door or a cover of an enclosure shall be hinged if:

- a) It gives access to any fuse, circuit breaker, or manually reset temperature control in other than a low voltage circuit; and
- b) An uninsulated live part is exposed during replacement of the fuse or resetting of the manually reset device.

Exception: A hinged cover is not required for a water heater in which the only fuse enclosed is:

- a) A control circuit fuse, provided the fuse and control circuit loads (other than a fixed control circuit load, such as a pilot lamp) are within the same enclosure; or*
- b) An extractor type fuse with its own enclosure.*

7.3 With reference to the requirement in 7.1, a door or a cover of an enclosure shall be provided with one of the following:

- a) An automatic latch such as a spring latch, a magnetic latch, or a dimple, or any other mechanical arrangement that will hold the door or cover closed and requires some effort by the user to open it;
- b) An automatic latch, as described in (a), and a captive screw or equivalent means that requires the use of a tool or key to open, if any live part other than the screw shell of a plug fuseholder is exposed inside the enclosure; or
- c) A cover or door interlocking mechanism that:
 - 1) Must be engaged in the closed position of the cover or door before a part is energized; and
 - 2) Will secure the door or cover in the closed position if provided as the sole means for securing the door or cover closed.

7.4 With reference to the requirement in 7.3(b), the captive screw may be omitted from the door or cover to a compartment housing uninsulated live parts if a captive screw is provided in a cover that must be opened to gain access to the inner door or cover.

7.5 With reference to the requirement in 7.3(b), an arrangement employing two mating hinged doors is acceptable if the automatic latch and captive screw are provided only on one door:

- a) If that door is designed to be opened first and closed last; and
- b) If the latch and screw will hold the other door closed.

7.6 A door or cover giving access to a fuse, circuit breaker, overload relay, or other overload protective device in other than a low voltage circuit shall be tight fitting and shall overlap the surface of the enclosure around the opening.

7.7 If an opening is provided to gain access to a control that is intended to be reset, adjusted, or otherwise manipulated by the user or service personnel, it shall not be possible to contact a live uninsulated or enamel insulated part with a 1/16 inch (1.6 mm) diameter rod applied as described in 7.8 and as illustrated in Figure 7.1.

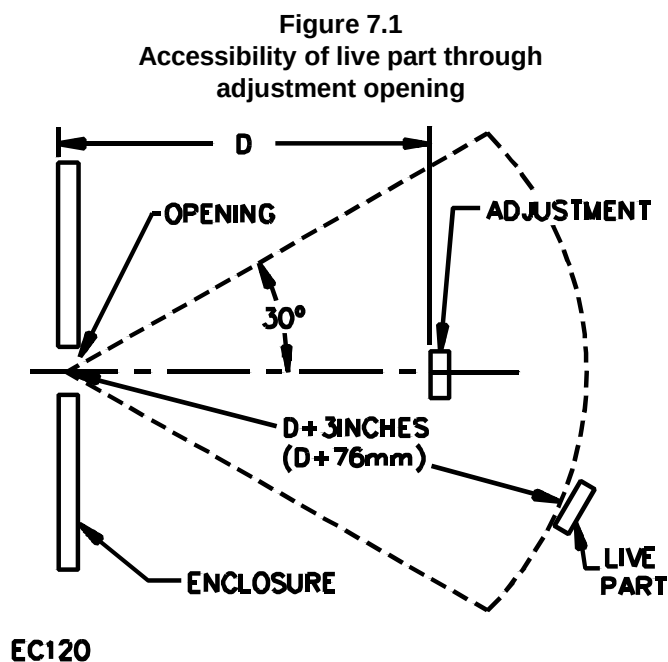


Figure 7.1 revised September 29, 1998

7.8 With reference to the requirement in 7.7, the rod is to be inserted through the opening shown in Figure 7.1 to its maximum depth and positioned in all possible directions without producing an angle of more than 30 degrees between the rod and a line connecting the center of the opening with the center of the face of the adjusting mechanism. The length of the rod beyond the opening is not to exceed the distance between the opening and the face of the adjusting mechanism by more than 3 inches (76.2 mm).

8 Mechanical Assembly

8.1 A water heater or an externally mounted component shall be assembled so that it will not be affected adversely by the vibration likely to occur during operation.

8.2 A switch, lampholder, attachment plug receptacle, or similar component shall be mounted securely and shall be prevented from turning or shifting.

Exception No. 1: The requirement does not apply to a switch that complies with all four of the following conditions:

- a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during the normal operation of the switch.*
- b) Means for mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) The spacings are not reduced below the minimum required values if the switch rotates or shifts.*
- d) Operation of the switch is by mechanical means rather than direct contact by persons.*

Exception No. 2: A lampholder of a type in which the lamp cannot be replaced (such as a neon pilot or indicated light in which the lamp is sealed in a nonremovable jewel) need not be prevented from turning or shifting if rotation cannot reduce spacings below the minimum required values.

8.3 The means for preventing the turning mentioned in 8.2 is to consist of more than friction between surfaces – for example, a lock washer is acceptable as a means of preventing a device having a single hole mounting means from turning or shifting.

8.4 An uninsulated live part shall be mounted so that it will be prevented from turning or shifting if such motion may result in a reduction of spacings below the minimum required in 27.1.

8.5 Friction between surfaces is not acceptable as a means to prevent shifting or turning of live parts, but a lock washer is acceptable.

9 Corrosion Resistance

9.1 Iron and steel parts shall be made corrosion resistant by painting, galvanizing, plating, or other equivalent means if the corrosion of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception: Cast iron parts, portions of heating element flanges exposed to air, and ASME coded pressure vessels are not required to be corrosion resistant.

9.2 The sheath employed to enclose a heating element shall be of a metal resistant to corrosion by water.