



UL 1453

Underwriters Laboratories Inc. Standard for Safety

Electric Booster and Commercial Storage Tank Water Heaters



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UL Standard for Safety for Electric Booster and Commercial Storage Tank Water Heaters, UL 1453

Fifth Edition, Dated June 10, 2004

Summary of Topics

These revisions to ANSI/UL 1453 are being issued to include the following changes in requirements:

Addition and Revision of Requirements to Relocate Component Standard References from Appendix A into the Body of the Standard as Component Requirements; and

Addition of New Requirements for Motors, Motor Overload Protection, and Low Voltage Transformers.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. 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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated April 29, 2011.

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Standard for Electric Booster and Commercial Storage Tank Water

Heaters

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June 10, 2004

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The most recent designation of ANSI/UL 1453 as an American National Standard (ANSI) occurred on July 15, 2011. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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APPENDIX A

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 85°C (185°F).

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

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 77°C (171°F) 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.

2 Components

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

2.1 revised July 15, 2011

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

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- b) Is superseded by a requirement in this standard.

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

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

3 Units of Measurement

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

3.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are root mean square (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 purpose of this standard the following definitions shall apply.

5.2 BOOSTER WATER HEATER – A water heater furnishing hot water from initially heated water, which is usually 60°C (140°F), with the minimum output water temperature being 77°C (171°F).

5.3 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.

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

5.3.1 added July 15, 2011

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

5.3.2 added July 15, 2011

5.4 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).

5.4.1 OPERATING CONTROL – A control intended to start or regulate the appliance during normal operation. An example would be a water temperature-regulating control. An operating control could provide Type 1 or Type 2 action. (See definitions 5.8 and 5.9.)

5.4.1 added April 7, 2009

5.4.1.1 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.

5.4.1.1 added July 15, 2011

5.4.2 PROTECTIVE CONTROL – A control intended to prevent the risk of electric shock, fire, or injury to persons during abnormal operation of the appliance. An example would be a water temperature limit control. A protective control always provides Type 2 action. (See definitions 5.8 and 5.9.)

5.4.2 added April 7, 2009

5.5 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 risks of injury to which they are exposed in performing a task, and of measures to minimize these risks to themselves or other persons.

5.6 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.

5.7 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.

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

5.8 revised July 15, 2011

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

5.9 revised July 15, 2011

CONSTRUCTION

6 Frame and Enclosure

6.1 General

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

6.1.2 The frame, if provided enclosure, and outer jacket 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.

6.1.2 revised July 15, 2011

6.1.3 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.

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

6.1.5 The outer jacket of the water heater shall be made of metal. If the outer jacket encloses insulated or uninsulated current-carrying parts, it shall have a minimum thickness as indicated in Table 6.1 or Table 6.2, as applicable.

6.1.5 added July 15, 2011

6.2 Enclosure materials

6.2.1 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 shall be considered with respect to thermal and chemical aging according to the requirements in the Standard for Polymeric Material - Use in Electrical Equipment Evaluations, UL 746C. An enclosure complying with the requirements of the Standard for Industrial Control Panels, UL 508A or the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50, would be considered to comply with the requirements of 6.2.1 (a) – (f).

6.2.1 revised July 15, 2011

6.2.2 An outer cabinet shall be judged with respect to the size, shape, and thickness of metal in accordance with 6.2.3.

6.2.3 The minimum thickness of sheet metal that serves as an electrical enclosure shall be as specified in Table 6.1 or 6.2.

Exception: An enclosure thinner than specified in Table 6.1 or 6.2 may be employed, as described in 6.2.4 and 6.2.5 if:

- a) The location of the enclosure meets the criteria described in 6.1.2;*
- b) The construction and location of components meet the criteria described in 6.1.2; or*
- c) The strength and rigidity of the frame and enclosure meet the criteria described in Section 45, Enclosure Strength Test.*

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Table 6.1
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	
Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Uncoated Inch (mm)	Zinc coated Inch (mm)
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 6.2
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 Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length Inches (cm)	Inch	(mm)
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	0.023	(0.58)
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)		
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	0.029	(0.74)
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)		
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	0.036	(0.91)
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)		
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	0.045	(1.14)
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)		
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	0.058	(1.47)
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)		
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	0.075	(1.91)
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)		
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	0.095	(2.41)
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)		
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	0.122	(3.10)
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)		
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	0.153	(3.89)
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)		

^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.

6.2.4 Unless thinner sheet metal would be acceptable in accordance with Table 6.1 or 6.2, a sheet metal enclosure that, in accordance with item (a) of the Exception to 6.2.3, 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.

6.2.5 With reference to item (b) of the Exception to 6.2.3, the minimum thickness of an enclosure may be less than specified in Table 6.1 or 6.2 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 6.1 or 6.2.

- 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.

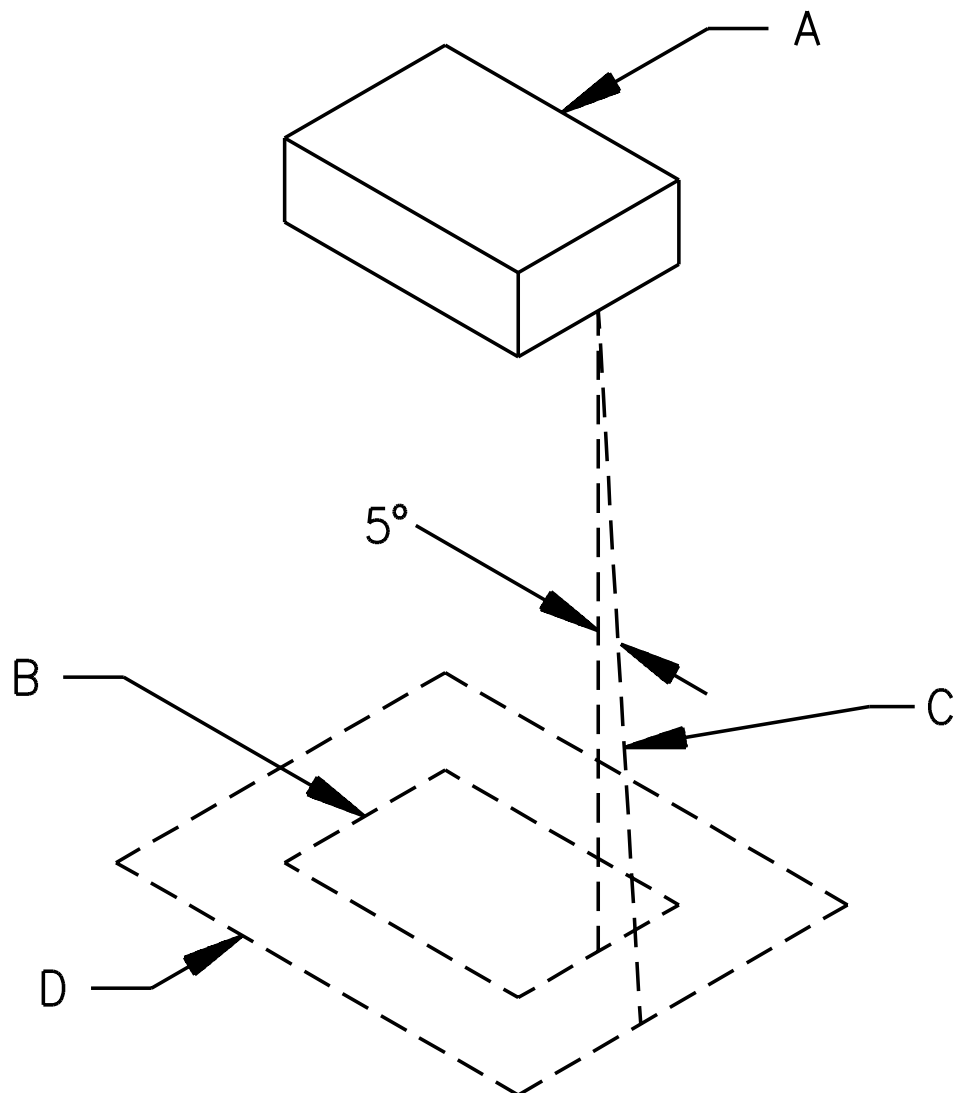
6.3 Emission of burning particles or molten metal

6.3.1 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.

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

6.3.3 The barrier mentioned in 6.3.2 shall be horizontal, shall be located as illustrated in Figure 6.1, and shall have an area no less than that described in Figure 6.1. Openings for drainage, ventilation, and the like may be employed in the barrier, provided that such openings do not permit molten metal, burning insulation, or the like to fall on combustible material.

Figure 6.1
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.

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6.4 Accessibility of live parts

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

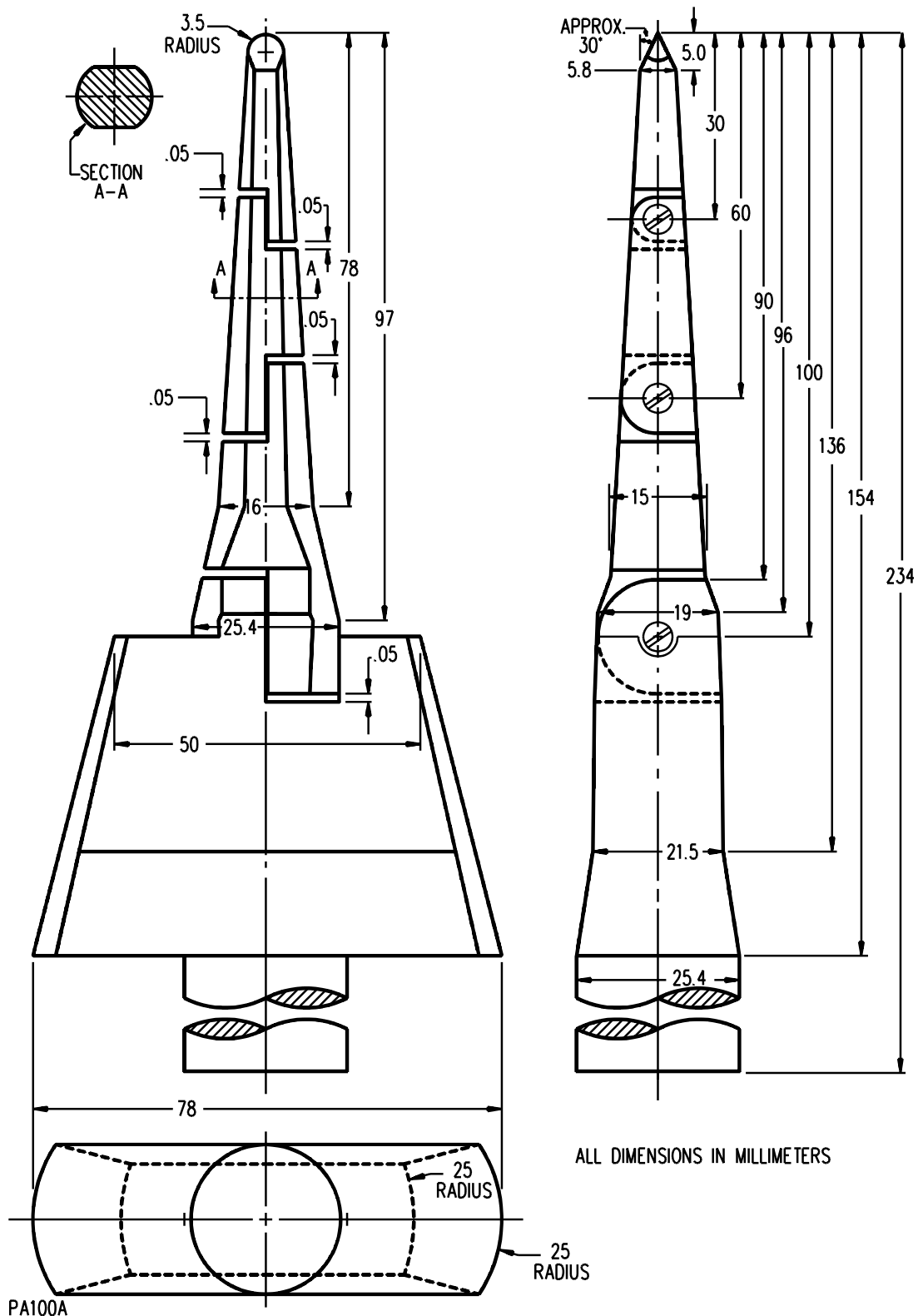
6.4.2 The enclosure may have an opening that has a minor dimension of less than 1 inch (25.4 mm) if a probe, as illustrated in Figure 6.2, inserted through the opening cannot be made to touch any uninsulated live part or enamel insulated wire that may cause an electric shock. The probe shall be applied in all possible articulated positions before, during, and after insertion.

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Figure 6.2
Articulate probe



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6.4.3 During the examination of a water heater in connection with the requirements in 6.4.1 and 6.4.2, a part of the outer enclosure that can 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 56.8 is provided.

6.4.4 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 56.5.

6.5 Ventilation openings

6.5.1 An opening for ventilation in the enclosure of a water heater or in an externally mounted component shall be located so that it does 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).

6.5.2 An opening for ventilation in the enclosure, other than in the bottom, shall be provided with one or more baffles that prevents 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 are not required when:

- 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 does not result in a risk of fire as shown by an investigation including short circuit testing.*

7 Heating Element Accessories

7.1 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.

7.2 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.

7.3 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.

7.4 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.

7.5 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.

7.6 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.

7.7 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.

8 Doors and Covers

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

8.2 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.*

8.3 With reference to the requirement in 8.1, 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.

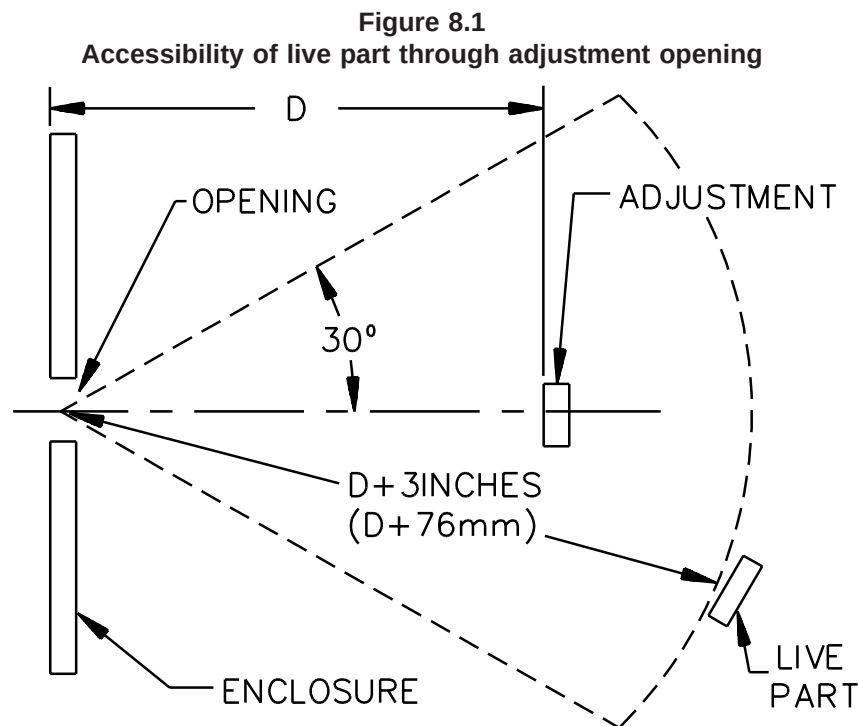
8.4 With reference to the requirement in 8.3(b), the captive screw may be omitted from the door or cover to a compartment housing uninsulated live parts if a captive screw is provided in a cover that must be opened to gain access to the inner door or cover.

8.5 With reference to the requirement in 8.3(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.

8.6 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.

8.7 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 8.8 and as illustrated in Figure 8.1.



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8.8 With reference to the requirement in 8.7, the rod is to be inserted through the opening shown in Figure 8.1 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).

9 Mechanical Assembly

9.1 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.

9.2 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.

9.3 The means for preventing the turning mentioned in 9.2 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.

9.4 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 28.1.

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

10 Corrosion Resistance

10.1 Iron and steel parts shall be made corrosion resistant by painting, galvanizing, plating, or other equivalent means if the corrosion of such unprotected parts results 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.

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

11 Supply Connections – Permanent Connection

11.1 General

11.1.1 A water heater shall have provision for connection of one of the permanent wiring systems that is acceptable for the water heater.

Exception: A water heater that is designed to permit removal for maintenance and repair may be connected as described in 12.1.1.

11.1.2 For the purpose of these requirements, field wiring terminals or leads are considered to be the terminals or leads to which power supply, equipment grounding, or control connections will be made in the field when the water heater is installed unless the wire is provided as part of the water heater and a pressure terminal connector, soldering loop, crimped eyelet, or other means for making the connection is factory assembled to the wire.

11.1.3 Electrical (Junction) boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A.

11.1.3 added July 15, 2011

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

11.1.4 added July 15, 2011

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

11.1.5 added July 15, 2011

11.1.6 If provided as part of the water heater, conduit shall comply with the Standard for Flexible Metal Conduit, UL 1 or the Standard for Electrical Rigid Metal Conduit Steel, UL 6.

11.1.6 added July 15, 2011

11.2 Wiring compartments

11.2.1 The location of a terminal box or compartment in which power supply connections are to be made shall be such that these connections are readily inspected after the water heater is installed as intended.

11.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the water heater to prevent it from turning or shifting.

11.2.3 A terminal or splice compartment shall be complete and shall enclose all field wiring terminals and all splices to be made in the field unless the water heater enclosure is otherwise complete; for example, unless all sides and a complete bottom are provided when the water heater is shipped from the factory. A ventilating opening shall not be located in the bottom of the terminal compartment. Baffled openings are acceptable in the sides of a terminal compartment.

11.2.4 A terminal or splice compartment shall be located so that when conduit connections are being made, internal wiring and electrical components are not exposed to mechanical damage or strain.

11.2.5 Sheet metal to which a wiring system is to be connected in the field shall have a thickness of no less than 0.053 inch (1.35 mm) if uncoated steel, no less than 0.056 inch (1.42 mm) if galvanized steel, and no less than 0.075 inch (1.91 mm) if nonferrous. For sheet metal in an application other than part of a wiring system, Tables 6.1 and 6.2 shall be used for minimum acceptable thicknesses.

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11.2.6 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall or if an equivalent construction is employed, there shall be no less than three, nor more than five threads, in the metal, and the construction of the device shall be such that a conduit bushing can be attached. If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall be no less than 3-1/2 threads in the metal and there shall be a smooth, rounded inlet hole for the conductors that:

- a) Affords protection to the conductors equivalent to that provided by a standard conduit bushing; and
- b) Has an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

11.2.7 A knockout in a sheet metal enclosure shall be secured in place, but shall be removable without undue deformation of the enclosure.

11.2.8 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout likely to be used during installation does not result in spacings between uninsulated live parts and the bushing less than the minimum acceptable spacings specified in Section 28, Spacings.

11.2.9 An outlet box, a terminal box, and a wiring compartment shall have the volume to accommodate the intended wiring. A trial installation is to be made using wires of the size indicated in 11.3.1 and conduit and fittings sized for the wire.

11.3 Field wiring terminals and leads

11.3.1 A water heater shall be provided with wiring terminals or leads for the connection of branch circuit conductors that have an ampacity as follows:

- a) For a water heater of 120 gallons (454 L) or less, no less than 125 percent of the current rating of the appliance; or
- b) For a water heater of more than 120 gallons, equal to or greater than the noncontinuous load plus 125 percent of the continuous load.

11.3.2 A field wiring terminal shall be provided with a soldering lug or with a pressure wire connector securely fastened in place; for example, firmly bolted or held by a screw.

Exception: A wire binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

11.3.3 A field wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces.