



UL 1453

STANDARD FOR SAFETY

Electric Booster and Commercial
Storage Tank Water Heaters

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

Sixth Edition, Dated March 29, 2016

Summary of Topics

This revision of ANSI/UL 1453 dated February 4, 2025 includes the following changes in requirements:

- Clarification of scope; [1.2](#), [1.4](#), [27.1.1](#) and [27.1.2](#)***
- Revision to dip tube requirements; Section [27](#)***
- Updates to align with UL style manual; [2.1](#) – [2.3](#), [2.5](#), [4.2](#) and [61.12](#)***

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 23, 2024.

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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 requirements are not intended to cover the health effects of a commercial water heater intended for installation in a potable water distribution system. Installation of a commercial water heater shall conform to the applicable installation codes such as the International Plumbing Code (IPC) and the Uniform Plumbing Code (UPC).

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.

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 A component of a product covered by this Standard shall:

- a) Comply with the requirements for that component as specified in this Standard;
- b) Be used in accordance with its rating(s) established for the intended conditions of use; and
- c) Be used within its established use limitations or conditions of acceptability.

2.2 A component of a product covered by this Standard 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;
- b) Is superseded by a requirement in this standard; or
- c) Is separately evaluated when forming part of another component, provided the component is used within its established ratings and limitations.

2.3 (Deleted)

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.

2.5 A component that is also intended to perform other functions such as overcurrent protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

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 Referenced Publications

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.

4.2 The following publications are referenced in this Standard:

ASME Boiler and Pressure Vessel Code

ASTM A90/A90M, Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM D570, Standard Test Method for Water Absorption of Plastics

ASTM E28, Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-And-Ball Apparatus

ASTM E162, Test for Surface Flammability of Materials Using a Radiant Heat Energy Source

ASTM E230/E230M, Standard Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples

IEC 61000-4-5, Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

NFPA 70, National Electrical Code

UL 1, Flexible Metal Conduit

UL 6, Electrical Rigid Metal Conduit Steel

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 62, *Flexible Cords and Cables*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 94, *Tests for Flammability of Plastic Material for Parts in Devices and Appliances*

UL 98, *Enclosed and Dead Front Switches*

UL 174, *Household Electric Storage Tank Water Heaters*

UL 248-1, *Low-Voltage Fuses – Part 1: General Requirements*

UL 248-5, *Low-Voltage Fuses – Part 5: Class G Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 353, *Limit Controls*

UL 467, *Grounding and Bonding Equipment*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 496, *Lampholders*

UL 498, *Attachment Plugs and Receptacles*

UL 508, *Industrial Control Equipment*

UL 508A, *Industrial Control Panels*

UL 514A, *Metallic Outlet Boxes*

UL 514B, *Conduit, Tubing, and Cable Fitting*

UL 723, *Test for Surface Burning Characteristics of Building Materials*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 746C, *Polymeric Material – Use in Electrical Equipment Evaluations*

UL 810, *Capacitors*

UL 817, *Cord Sets and Power Supply Cords*

UL 873, *Temperature Indicating and Regulating Equipment*

UL 969, *Marking and Labeling Systems*

UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1004-7, *Electronically Protected Motors*

UL 1059, *Terminal Blocks*

UL 1998, *Software in Programmable Components*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-4, *Fuseholders – Part 4: Class CC*

UL 4248-5, *Fuseholders – Part 5: Class G*

UL 4248-6, *Fuseholders – Part 6: Class H*

UL 4248-8, *Fuseholders – Part 8: Class J*

UL 4248-9, *Fuseholders – Part 9: Class K*

UL 4248-11, *Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse*

UL 4248-12, *Fuseholders – Part 12: Class R*

UL 4248-15, *Fuseholders – Part 15: Class T*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

UL 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

UL 60947-4-1, *Low-Voltage Switchgear and Controlgear – Part 4-1: Electromechanical Contactors and Motor-starters*

UL 60947-5-2, *Low-voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches*

UL 61058-1, *Switches for Appliances – Part 1: General Requirements*

UL 61131-2, *Programmable Controllers – Part 2: Equipment Requirements and Tests*

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.

5.4 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.

5.5 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.

5.6 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).

5.7 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 [5.13](#) and [5.14](#).)

5.8 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.

5.9 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 [5.13](#) and [5.14](#).)



5.10 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.

5.11 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.

5.12 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.

5.13 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 – Part 1: General Requirements, UL 60730-1.

5.14 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 – Part 1: General Requirements, UL 60730-1.

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.

6.1.3 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 A sheet metal outer jacket that also encloses insulated or uninsulated current-carrying parts shall have a minimum thickness as indicated in [Table 6.1](#) or [Table 6.2](#), as applicable.

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

Exception: An outer jacket is required to comply only with the requirements in [Table 6.5](#), when the outer jacket:

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

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).

6.2.2 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 [Table 6.2](#).

Exception: An enclosure thinner than specified in [Table 6.1](#) or [Table 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 [47](#), Enclosure Strength Test.*

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		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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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.

^d Sheet steel for an enclosure intended for outdoor use shall comply with the requirements for outdoor use equipment.

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		Maximum length ^c		Maximum width ^b		Maximum length ^c	
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited	
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	
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	
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	
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	
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	
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	
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	
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	
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.

^d Sheet steel for an enclosure intended for outdoor use shall comply with the requirements for outdoor use equipment.

Table 6.3
Polymeric material enclosure application code

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

Table 6.4
Polymeric material enclosure property and test requirements

Application code (see Table 6.3 for code)	Minimum flammability classification ^a	Resistance to ignition		Electrical				End product tests ^d			
		Maximum hot wire (HWI) ^b PLC ^c	Maximum high current (HAI) ^b PLC ^c	Minimum dielectric strength, volts ^b	Maximum high voltage track rate (HVTR) ^b PLC ^c	Maximum comparative tracking index (CTI) ^b PLC ^c	Volume resistivity ^b 50 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

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

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

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

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

Table 6.5
Polymeric outer jacket

Part	Impact test ^a	Burning characteristics		Moisture resistance ^d
		Maximum flame spread index ^b	Minimum flammability classification ^c	
Outer jacket, indoor only				
A. Less than 10 square feet (0.93 m ²) and all dimension less than 6 feet (1.83 m)	X	–	HB	–
B. 10 square feet or more, or a single dimension greater than 6 feet	X	200	HB	–
Outer jacket, damp locations				
A. Less than 10 square feet (0.93 m ²) and all dimension greater than 6 feet (1.83 m)	X	–	HB	X
B. 10 square feet or more, or a single dimension greater than 6 feet	X	200	HB	X
^a Test is to be conducted in accordance with the Resistance to Impact Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. ^b The maximum flame spread index is to be determined by the method described in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or in accordance with the Test for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162. ^c The flammability classification is to be determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. ^d Moisture resistance is to be determined in accordance with the Standard Test Method for Water Absorption of Plastics, ASTM D570, and the method for measuring water absorption of polymeric materials in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.				

6.2.4 Unless thinner sheet metal would be acceptable in accordance with [Table 6.1](#) or [Table 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 [Table 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 [Table 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

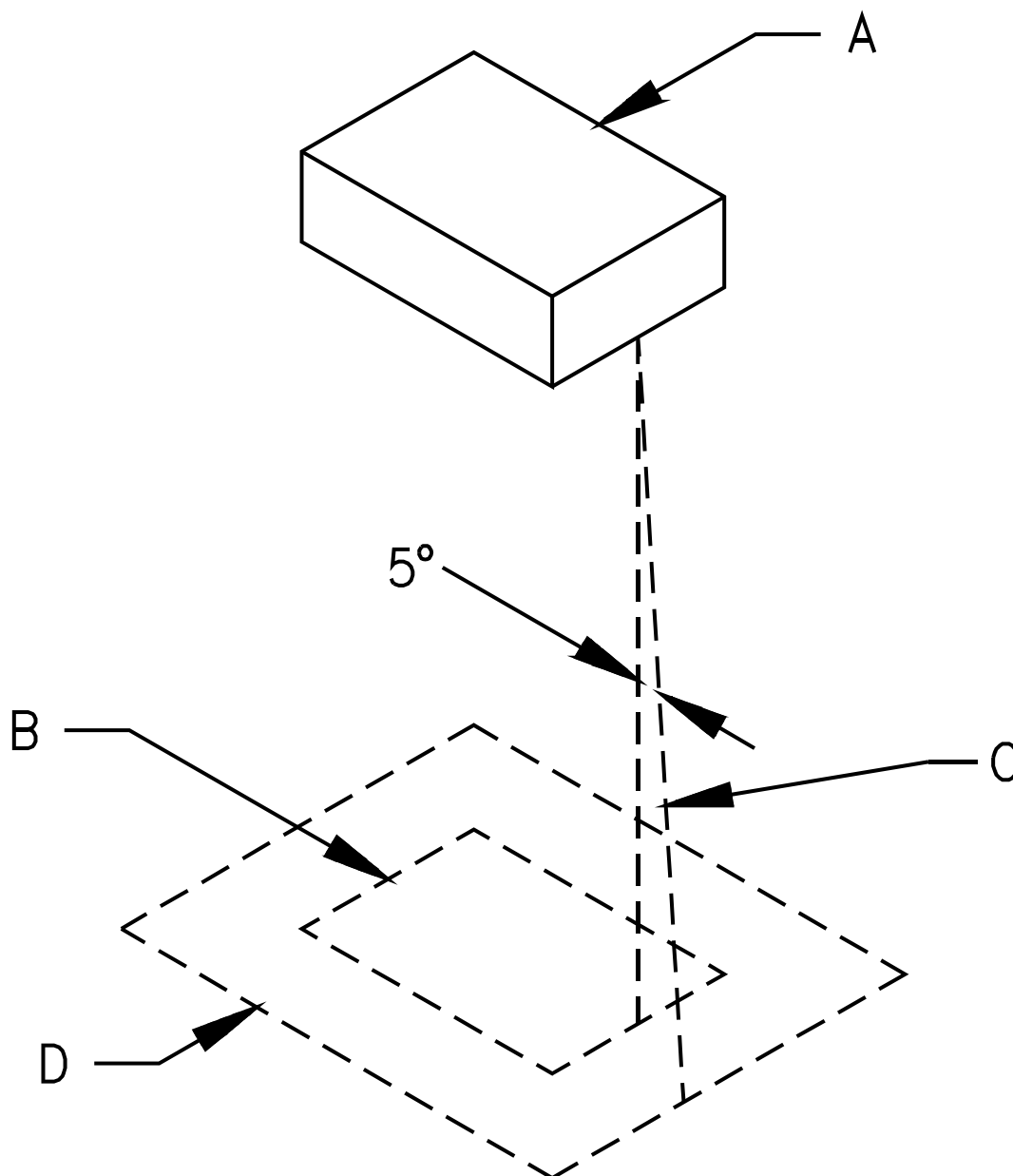
6.3.1 The enclosure of a water heater shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the water heater is supported.

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



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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.

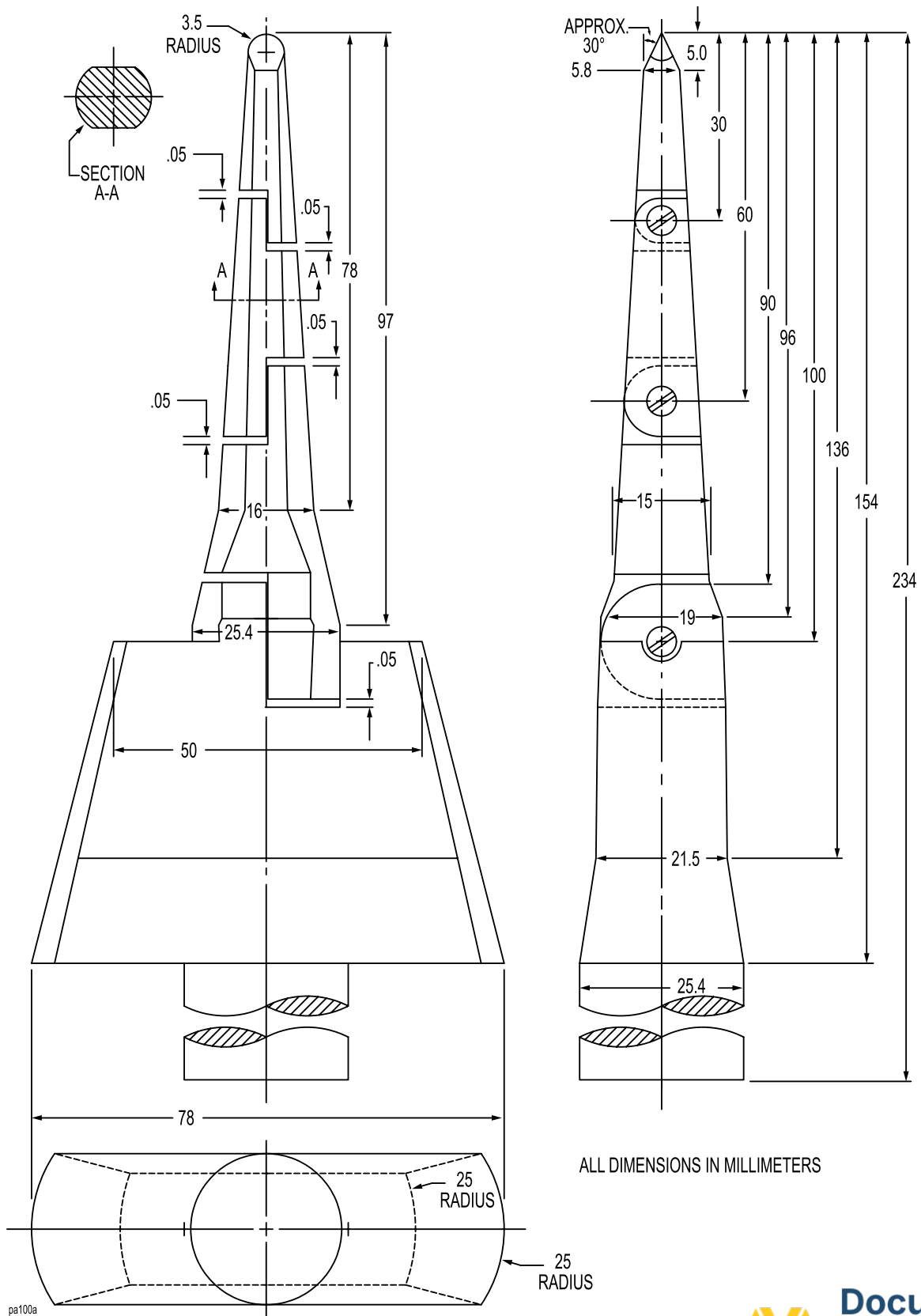
D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

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.

Figure 6.2
Articulate probe



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 [58.8](#) 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 [58.5](#).

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