UL 2523

STANDARD FOR SAFETY

Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, And Boilers

UL Standard for Safety for Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, And Boilers, UL 2523

First Edition, Dated December 22, 2009

Summary of Topics

These revisions to ANSI/UL 2523 are being issued to address:

Temperature rise vs, absolute temperature values in Table 55.1

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 revised requirements are substantially in accordance with Proposal(s) on this subject dated February 9, 2018.

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UL 2523

Standard for Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, And Boilers

Prior to the first edition, the requirements for the products covered by this standard were included in the Outline of Investigation for Solid Fuel-Fired Water Heaters And Boilers, SU 2523.

First Edition

December 22, 2009

This ANSI/UL Standard for Safety consists of the First Edition including revisions through March 16, 2018.

The most recent designation of ANSI/UL 2523 as an American National Standard (ANSI) occurred on March 16, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements apply to factory built manually and/or automatically fueled solid fuel-fired hydronic heating appliances, water heaters and boilers, as defined in Section 5, Glossary, intended to be fixed non-moveable appliances.

1.2 The appliances are intended to burn solid fuels, such as wood, coal, or any other biomass fuel, as specified by the manufacturer.

1.3 The appliances are provided with an integral chimney and termination or intended for connection to chimneys for residential type and building heating appliances or for building heating appliances in compliance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211, and intended for installation in compliance with the National Electrical Code, ANSI/NFPA 70; and the International Mechanical Code (ICC), International Residential Code (ICC) and the Uniform Mechanical Code (IAPMO), as applicable.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

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 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 apply.

5.2 AIR SHUTTER – An adjustable device for varying the size of the air inlet or inlets regulating primary air, secondary air, or both. It may be either manually or automatically operated.

5.3 APPLIANCE FLUE – The passages within the product that conduct the products of combustion (flue gases) through the product.

5.4 BOILER – A closed vessel in which water or some other liquid is heated or in which steam is generated or superheated, under pressure or vacuum, by direct application of heat.

5.5 BOILER, HIGH PRESSURE STEAM – A boiler in which steam is generated at a pressure higher than 15 psig (103 kPa).

5.6 BOILER, HIGH TEMPERATURE WATER – A boiler intended for operation at a pressure exceeding 160 psig (1103 kPa) or at a temperature exceeding 250°F (121°C) or both.

5.7 BOILER, HOT WATER – A boiler that furnishes hot water at a pressure not exceeding 160 psig (1103 kPa) and at a temperature not exceeding 250°F (121°C).

5.8 BOILER, LOW PRESSURE STEAM – A boiler in which steam is generated at a pressure not exceeding 15 psig (103 kPa).

5.9 CHIMNEY CONNECTOR – The pipe that connects a fuel-burning product to a chimney.

5.10 COMBUSTIBLE MATERIAL – Combustible material as pertaining to materials adjacent to or in contact with heat-producing appliances, chimney connectors and vent connectors, steam and hot water pipes, refers to material made of or surfaced with wood, compressed paper, plant fibers, or other material that will ignite and burn. Such material shall be considered as combustible even through flameproofed, fire-retardant treated, or plastered.

5.11 COMBUSTIBLE, NONCOMBUSTIBLE PRODUCTS – These terms, as used in this standard, are defined in the Standard Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances, NFPA 97.

5.12 CONTROL, LIMIT – An automatic control responsive to changes in pressure or temperature and intended to limit the operation of the controlled equipment.

5.13 CONTROL, SAFETY – Any automatic control, such as a relay or switch, used in conjunction with other auxiliary equipment to form a safety control system that is relied upon to reduce the risk of fire, electric shock, or injury to persons.

5.14 CONTROL, THERMOSTATIC DAMPER – An automatic control responsive to changes in temperature. Usually acts through direct mechanical linkage to reduce or increase the supply of air needed for combustion, thereby regulating the combustion rate and limiting the operation of the product when the product is burning solid fuel.

5.15 DAMPER – A valve or plate that regulates draft or flow of flue gases or inlet combustion air. May be either manually or automatically operated.

5.16 DRAFT REGULATOR – A device that functions to maintain a desired draft in the product by automatically reducing the chimney draft to the desired value.

5.17 ELECTRICAL CIRCUITS :

a) Circuit – A circuit involving a potential of not more than 600 volts and having circuit values in excess of those of a low-voltage circuit.

b) Low-Voltage Circuit – A circuit involving a potential of not more than 30 volts alternating current (42.4 peak or direct current) and supplied by a NEC Class 2 transformer, or by a battery, or by a battery and fixed impedance, or by a transformer and fixed impedance each of which, as a unit, is either in compliance with requirements for a Class 2 transformer or is otherwise limited to a maximum output of 100 volt-amperes. A circuit derived by connecting resistance in series with a high-voltage circuit as a means of limiting the voltage and current is not considered a low-voltage circuit.

c) Isolated Limited Secondary Circuit – A circuit of limited energy output derived from a isolated secondary winding of a transformer having a maximum capacity of 100 volt-amperes and open-circuit secondary voltage rating not exceeding 1000 volts.

5.18 GRATE – A metal frame provided by the manufacturer for supporting the fuel within an appliance.

5.19 HEARTH – The floor area within the fire chamber of an appliance.

5.20 HYDRONIC HEATING APPLIANCE – An appliance that maintains a constant atmospheric internal working pressure and is designed to heat a liquid, such as water, that is circulated between a heating load and the heating source (appliance).

5.21 INDIRECT-FIRED VENTED PRODUCT – A product in which the products of combustion and the medium being heated (circulating air, for example) are segregated by the walls of the fire chamber and flues; it is provided with an integral chimney termination or a flue collar to accommodate a chimney connector.

5.22 RADIATION SHIELD – A separate panel or separate panels interposed between heating surfaces and adjacent objects for the purpose of reducing heat transmission by radiation.

5.23 RADIATOR – Auxiliary heat transfer surfaces within the casing, connected between the combustion chamber and the flue collar.

5.24 SAFETY SHUTDOWN – The means to interrupt the combustion air and automatic fuel supply of a solid fuel fired appliance, resulting in extinguishment of the combustion process of the fuel.

5.25 THERMOSTAT – An automatic control actuated by temperature change to maintain temperatures between predetermined limits.

5.26 WATER HEATER – A vessel in which water is heated by the combustion of fuels and is withdrawn for external use, including all controls and devices necessary to prevent water temperatures from exceeding 210°F (99°C), with an internal maximum working pressure of less than 160 psi (1103 kPa) and storage water volume not in excess of 120 gallons (454 L).

CONSTRUCTION

ALL APPLIANCES

6 General

6.1 Electrical equipment and wiring shall be arranged so that water will not drip or run on them during normal usage or from a connection required to be uncoupled for servicing the device.

6.2 Attachment plugs or separable connectors shall not be used in circuits when the breaking or making of the circuit by such devices may result in operation of the equipment in a manner that involves a risk of fire, electric shock, or injury to persons.

7 Corrosion Protection

7.1 Iron and steel parts shall be protected against corrosion by painting, galvanizing, plating or other equivalent means if the malfunction of such unprotected part would be likely to result in a hazardous condition.

Exception: Cast-iron parts, cast-aluminum parts and ASME coded pressure vessels are not required to be protected against corrosion.

7.2 An evaluation of any condensation that may collect in the flue gas ductwork or components shall be undertaken to determine the pH content. The pH content is to be measured as undiluted condensate. An initial condensate sample is to be taken upon a cold start and additional samples are to be taken to be representative of all firing conditions that produce condensate. The pH measurement is to be performed in accordance with the Standard Test Method for pH of Aqueous Solutions With the Glass Electrode, ASTM E70. If the pH is greater than or equal to 3.0, no further evaluation of the effects of the condensate is required. If the pH concentration is less than 3.0, the venting system of the appliance shall be evaluated in accordance with the Standard for Venting Systems for Gas Burning Appliances, Categories II, III, and IV, UL 1738.

8 Protection of Users and Service Personnel

8.1 An uninsulated high-voltage live part and a moving part that may involve a risk of injury to persons shall be located, guarded, or enclosed to reduce the likelihood of unintentional contact by personnel performing service functions that may have to be performed with the equipment energized.

Exception: A moving part is not required to comply with 8.1 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

8.2 Service functions which may have to be performed with the equipment energized include:

a) Adjusting the setting of temperature controls with or without marked dial settings;

b) Resetting control trip mechanism;

c) Operating manual switches; or

d) Adjusting air shutters or air-flow dampers.

A factory set and sealed control is not considered to be adjustable.

8.3 The requirements of 8.1 are not applicable to mechanical service functions which are not normally performed with the equipment energized.

8.4 Adjustable or resettable electrical control or manual switching devices may be located or oriented with respect to uninsulated live parts, so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the normal direction of access if uninsulated live parts or moving parts that may involve a risk of injury to persons are:

a) Not located in front, in the direction of access, of the mechanism; and

b) Are not located within 6 inches (152 mm) on any side or behind the mechanism, unless guarded.

8.5 An electrical control component that may require examination, adjustment, servicing, or maintenance while energized, not including voltage measurements, shall be located and mounted with respect to other components and grounded metal parts so that it is accessible for electrical service functions without subjecting the serviceman to a risk of electric shock from adjacent uninsulated live parts or to unintentional contact from adjacent moving parts that may involve a risk of injury to persons.

8.6 Accessibility and protection from a risk of fire, electric shock, or injury to persons may be obtained by mounting the control components in an assembly so that unimpeded access is provided to each component through the access cover or panel in the outer cabinet and the cover of the control assembly enclosure with the following arrangement:

a) The components are located with respect to the access opening in the cabinet so that the farthest component in the control assembly is not more than 14 inches (356 mm) from the plane of the access opening.

b) Uninsulated live parts outside the control assembly projected clear space (except for live parts within a control panel) or unguarded moving parts that may involve a risk of injury to persons are located not closer than 6 inches (152 mm) from any side of the access area. The projected clear space is considered to be bounded on the sides by the projection of the

smallest rectangular perimeter surrounding the outside edge of the components or control enclosure when provided. The access area is considered to be bounded on the sides by the projection of the perimeter of the access opening in the outer cabinet to the closest rectangular perimeter surrounding the outside edge of the component or control enclosure.

c) The volume generated by the projected clear space of the control assembly to the access opening in the outer cabinet (within the access area is completely free of obstructions, including wiring).

d) Access to the components in the control assembly is not impeded in the direction of access by other components or by wiring in this assembly.

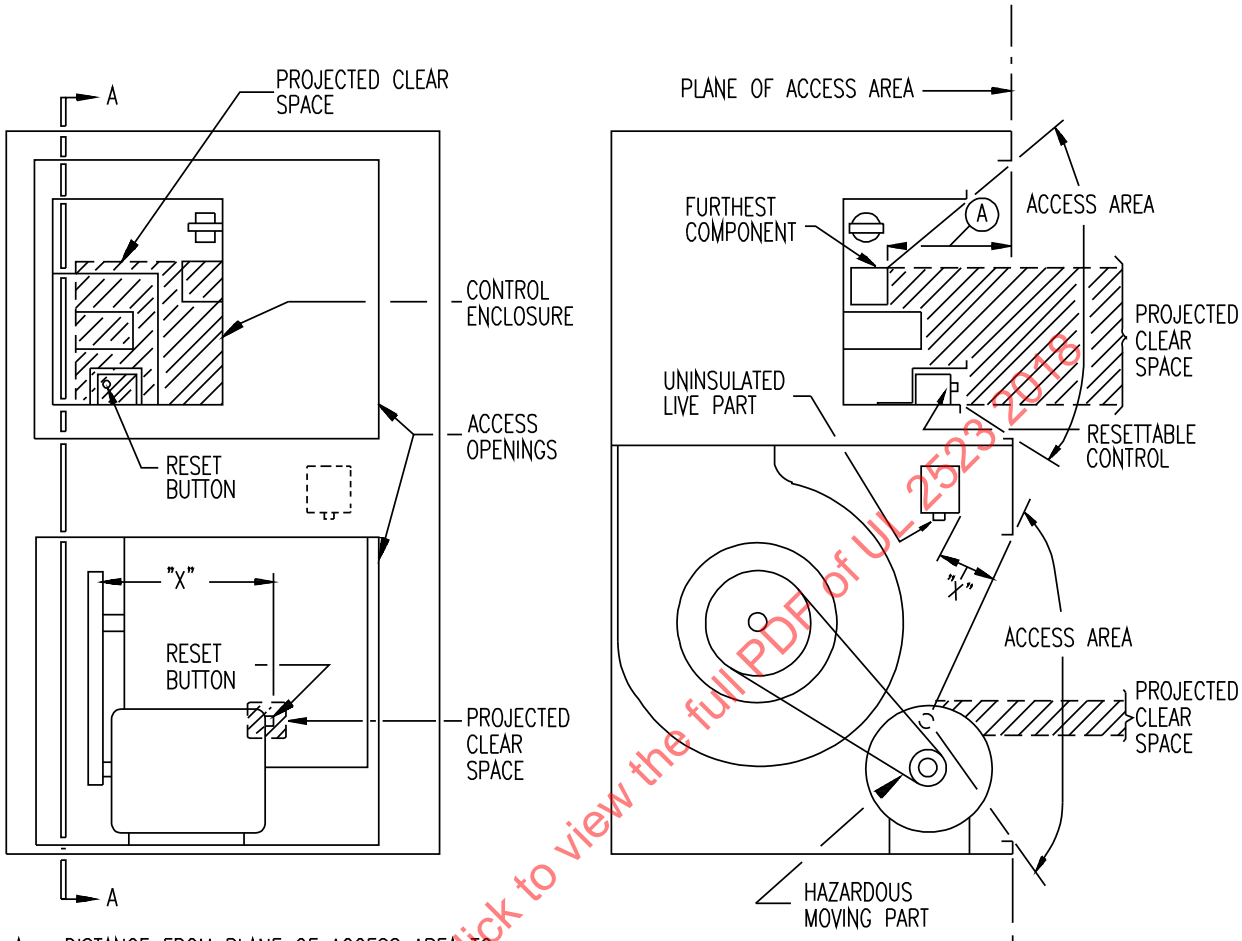
e) Extractor-type fuseholders and snap switches mounted through the control assembly enclosure shall be located so that:

1) There is unimpeded access to these components through the access opening in the outer cabinet; and

2) They are not immediately adjacent to uninsulated live parts outside the control assembly enclosure, unless guarded.

Also see Figure 8.1.

Figure 8.1
Accessibility and protection



A = DISTANCE FROM PLANE OF ACCESS AREA TO FURTHEST COMPONENT – 14" (355.6 mm) MAXIMUM.

"X" = MINIMUM DISTANCE FROM HAZARDOUS MOVING PARTS, OR UNINSULATED LIVE PARTS TO ACCESS AREA = 6" (152.4mm) MINIMUM.

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8.7 Components in a low-voltage circuit shall comply with the requirements of 8.5 in their relation to uninsulated live parts in a high-voltage circuit and to hazardous moving parts.

8.8 The following are not considered to be uninsulated live parts:

a) Coils of controllers;

b) Relays and solenoids;

c) Transformer windings, if the coils and windings are provided with insulating overwraps;

d) Enclosed motor windings;

e) Insulated terminals and splices; and

f) Insulated wires.

8.9 Moving parts such as fan blades, blower wheels, pulleys, belts, and the like, which may cause injury shall be enclosed or guarded (See 8.13 for requirements pertaining to automatically fed appliances). If the removal of doors, panels, or shields will expose such moving parts;

a) The opening or removal of the door, panel, or shield shall require the use of tools;

b) An interlocking device shall shut off the mechanism; or

c) A warning marking shall be displayed as described in 72.10.

Exception: A moving part is not required to comply with 8.9 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

8.10 The distance from an opening in a required guard or enclosure to the moving part mentioned in 8.9 shall be in accordance with Table 8.1, but the minor dimension of the opening shall not in any case exceed 3 inches (76.2 mm). For an opening having a minor dimension intermediate between two of the values included in the table, the distance from the opening to the moving part shall be not less than that found by appropriate interpolation between the corresponding values in the right-hand column of the table. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22 N).

Table 8.1
Dimensions of openings

Minor dimensions of opening		Minimum distance from opening to moving part	
inches[a]	(mm)	inches[a]	(mm)
1/4	(6.4)	1/2	(12.7)
3/8	(9.5)	1-1/2	(38.1)
1/2	(12.7)	2-1/2	(63.5)
3/4	(19.1)	4-1/2	(114)
1	(25.4)	6-1/2	(165)
1	(25.4)	6-1/2	(165)
1	(25.4)	6-1/2	(165)
1-1/2	(38.1)	10-1/2	(267)
2	(50.8)	14-1/2	(369)
over 2	(over 50.8)	30	(762)

[a] Openings less than 1/4 inch (6.4 mm) are not to be considered.

8.11 A moving part shall not be considered when evaluating for compliance with 8.1 and 8.9 if the part is unlikely to be contacted through the opening because of fixed components, including baffles.

8.12 The fuel hopper of an automatically fueled appliance shall be constructed such that fuel or fuel residue cannot enter areas within the appliance electrical enclosure or come into contact with exterior surfaces of the fire chamber. Fuel hopper sections shall be fastened together securely such that they do not rely solely on a sealing compound or tape for tightness.

8.13 The fuel hopper of an automatically fueled appliance shall have a lid or door with a direct interlock to the fuel feed auger motor so that the auger is disabled when the hopper is opened.

8.14 If provided, the hopper lid/door seal gasketing shall be attached to the lid/door, or the design and construction shall be such that damage to the gasketing during normal operation and filling of the hopper is prevented.

8.15 When components require removal, for example, during periodic maintenance, such removal shall not render the gasket or seal incapable of forming a suitable seal when the components are reassembled with a gasket or seal replacement.

9 Enclosures

9.1 General

9.1.1 Uninsulated live high-voltage parts shall be enclosed or guarded to prevent unintentional contact by persons during normal use of the appliance.

9.1.2 Among the factors taken into consideration when evaluating the acceptability of an enclosure are:

a) Mechanical 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 conditions of normal or abnormal use.

For a nonmetallic enclosure or part of an enclosure, all these factors are considered with respect to thermal and chemical aging, in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

9.1.3 The enclosure shall reduce the likelihood of the emission of molten metal, burning insulation, flaming particles, or the like through openings onto combustible material, including the surface on which the equipment is mounted.

9.1.4 Where the design and location of the component and the strength and rigidity of the outer cabinet warrant, an individual enclosure of thinner metal than specified in Table 9.1 or 9.2 whichever applies, may be employed.

Table 9.1
Minimum thickness of sheet metal for enclosures – carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing				Minimum thickness, inches (mm)	
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length		Uncoated	Metal coated
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(MSG)	(GSG)
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)	(24)	(24)
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)	(22)	(22)
8.0	(20.4)	Not limited		12.0	(30.5)	Not limited		0.32 (0.81)	0.034 (0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	(20)	(20)
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)	(18)
18.0	(45.7)	Not limited		33.0	(83.8)	Not limited		0.060 (1.53)	0.063 (1.61)
25.0	(63.5)	31.0	(78.7)	35.0	(89.0)	43.0	(109.2)	(15)	(15)
25.0	(63.4)	Not limited		39.0	(99.1)	Not limited		0.067 (1.70)	0.070 (1.78)

Table 9.1 Continued on Next Page

Table 9.1 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing				Minimum thickness, inches (mm)	
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length		Uncoated	Metal coated
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(MSG)	(GSG)
29.0	(73.7)	36.0	(91.4)	41.0	(104.0)	51.0	(129.5)	(14)	(14)
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080 (2.04)	0.084 (2.13)
35.0	(89.0)	47.0	(119.4)	54.0	(137.1)	66.0	(167.6)	(13)	(13)
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093 (2.36)	0.097 (2.46)
42.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	(12)	(12)
52.0	(135.1)	Not limited		80.0	(203.2)	Not limited		0.108 (2.74)	0.111 (2.80)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	(11)	(11)
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)	(10)	(10)

[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 a 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 which are not supported along one side, e.g., side panels of boxes, the length of the unsupported side shall be lifted to the dimensions specified unless the side in question is provided with a flange at lease 1/2 inch (12.7 mm) wide.

Table 9.2
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		inches	(mm)
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(AWG)	
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)	(22)	
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)	(20)	
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)	(18)	
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)	(16)	
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)	(14)	
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075	(1.91)
20.0	(50.8)	25.0	(63.4)	45.0	(114.3)	55.0	(139.7)	(12)	
25.0	(63.4)	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)	(10)	
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)	(8)	
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)	(6)	

Table 9.2 Continued on Next Page

Table 9.2 Continued

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	(mm)
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	(AWG)	

[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, such as, 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 which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at lease 1/2 inch (12.7 mm) wide.

9.1.5 Electrical parts within the outer cabinet are not required to be individually enclosed if the assembly conforms with all of the following:

a) Their design and location with respect to openings in the outer cabinet will not result in the emission of flame or molten metal through openings in the cabinet or if it can be shown that failure of the component would not result in a risk of fire;

b) There are no openings in the bottom of the compartment in which the part is located which would permit dropping of molten metal, and the like, onto combustible material;

c) The part is not in proximity to combustible material other than electrical insulation;

d) The part is not located closer than 5 inches (127 mm) to the outer cabinet unless the thickness of sheet metal is in compliance with Table 9.1;

e) The part is not located in an air-handling compartment;

f) The thickness of the outer cabinet is not less than two-gage thicknesses thinner than indicated in Table 9.1 for the maximum dimensions of the cabinet enclosure.

g) The part is not subject to unintentional contact by persons. See Protection of Users and Service Personnel, Section 8.

9.1.6 The requirements of 9.1.5 apply only to parts of high-voltage circuits as defined by 5.17.

9.1.7 All intended mounting positions of the unit shall be considered when evaluating compliance to 9.1.3.

9.1.8 Cabinet compartments housing gas piping and controls shall be ventilated.

9.1.9 Steel enclosures shall be protected against corrosion by painting, plating, or equivalent means.

9.1.10 The thickness of a sheet metal enclosure shall be as indicated in Tables 9.1 and 9.2.

Exception: When the design and location of components and the strength and rigidity of the outer cabinet warrant, an individual enclosure thinner than specified in Tables 9.1 and 9.2 is able to be employed.

9.1.11 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) (No. 20 MSG) if uncoated steel, not less than 0.034 inch (0.86 mm) (No. 20 GSG) if galvanized steel, and not less than 0.045 inch (1.14 mm) if nonferrous.

9.1.12 If insulating material other than electrical insulation is provided within the enclosure, consideration shall be given to the burning characteristics and combustibility of the material and the proximity of an ignition source.

9.1.13 Terminal housings of motors, to which connections are to be made in the field, shall be of metal and shall be sized in accordance with the National Electrical Code, NFPA 70.

9.1.14 A junction box partially formed by another part such as a fan scroll or a motor casing shall fit such that:

a) An opening between the box and motor frame having a dimension exceeding 1/2 inch (12.7 mm) does not permit a flat feeler gauge, 5/64 by 1/2 inch (2.0 by 12.7 mm) wide to enter; and

b) An opening between the box and motor frame having no dimension exceeding 1/2 inch (12.7 mm) does not permit the entrance of a 13/64 inch (5.2 mm) diameter rod.

9.1.15 The criteria for evaluating an opening in an electrical enclosure are given in the following items and the related figures:

a) An opening that does not permit entrance of a 3/4 inch (19.1 mm) diameter rod is acceptable if:

1) A probe, as illustrated in Figure 9.1, cannot be made to touch any uninsulated live part when inserted through the opening; and

2) A probe, as illustrated in Figure 9.2, cannot be made to touch enamel insulated wire when inserted through the opening.

b) An opening that permits entrance of a 3/4 inch (19.1 mm) diameter rod is acceptable under the conditions described in Figure 9.3.

Figure 9.1
Probe for uninsulated live metal parts

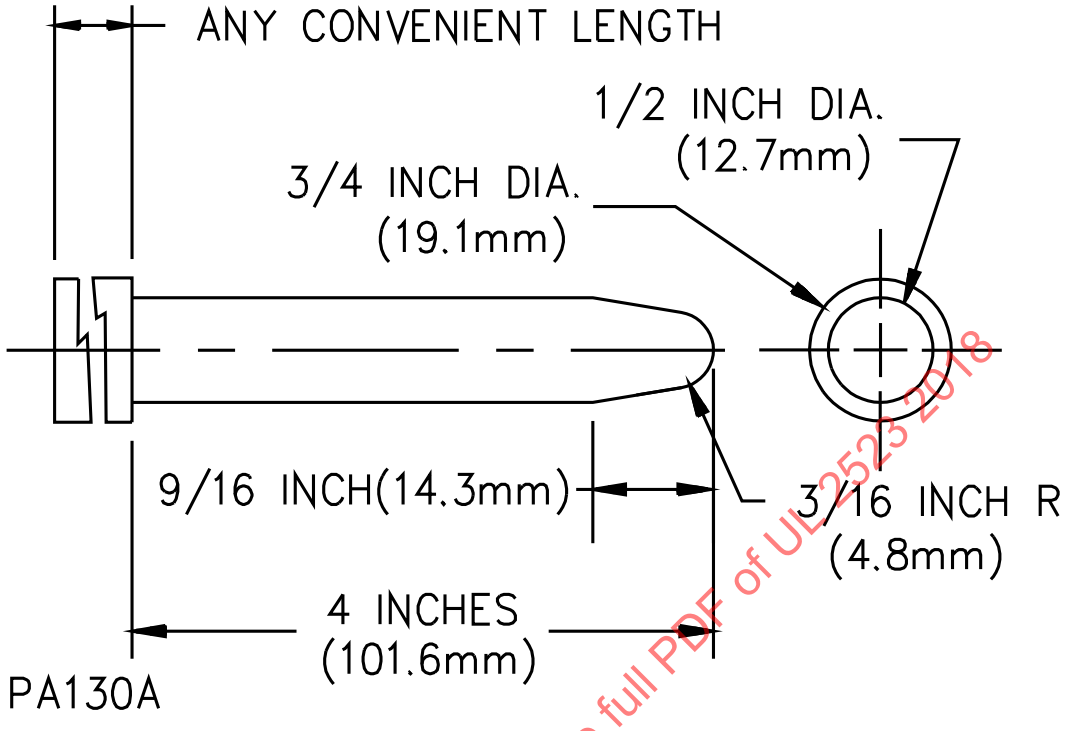


Figure 9.2
Probe for film-coated wire

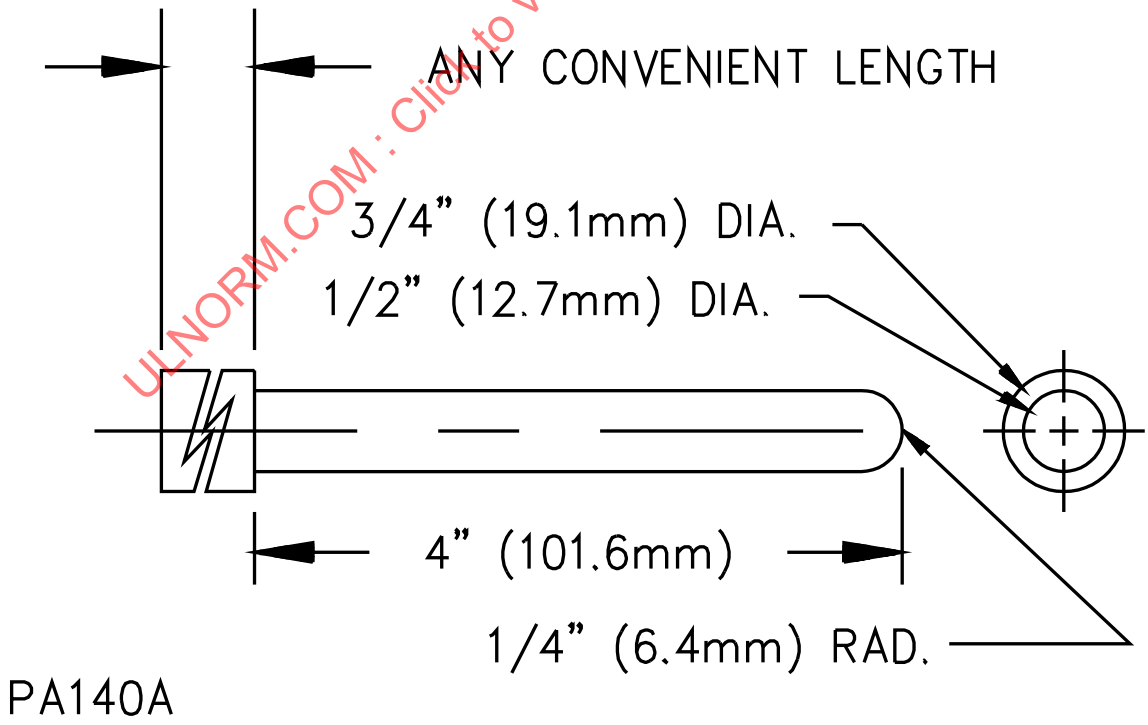
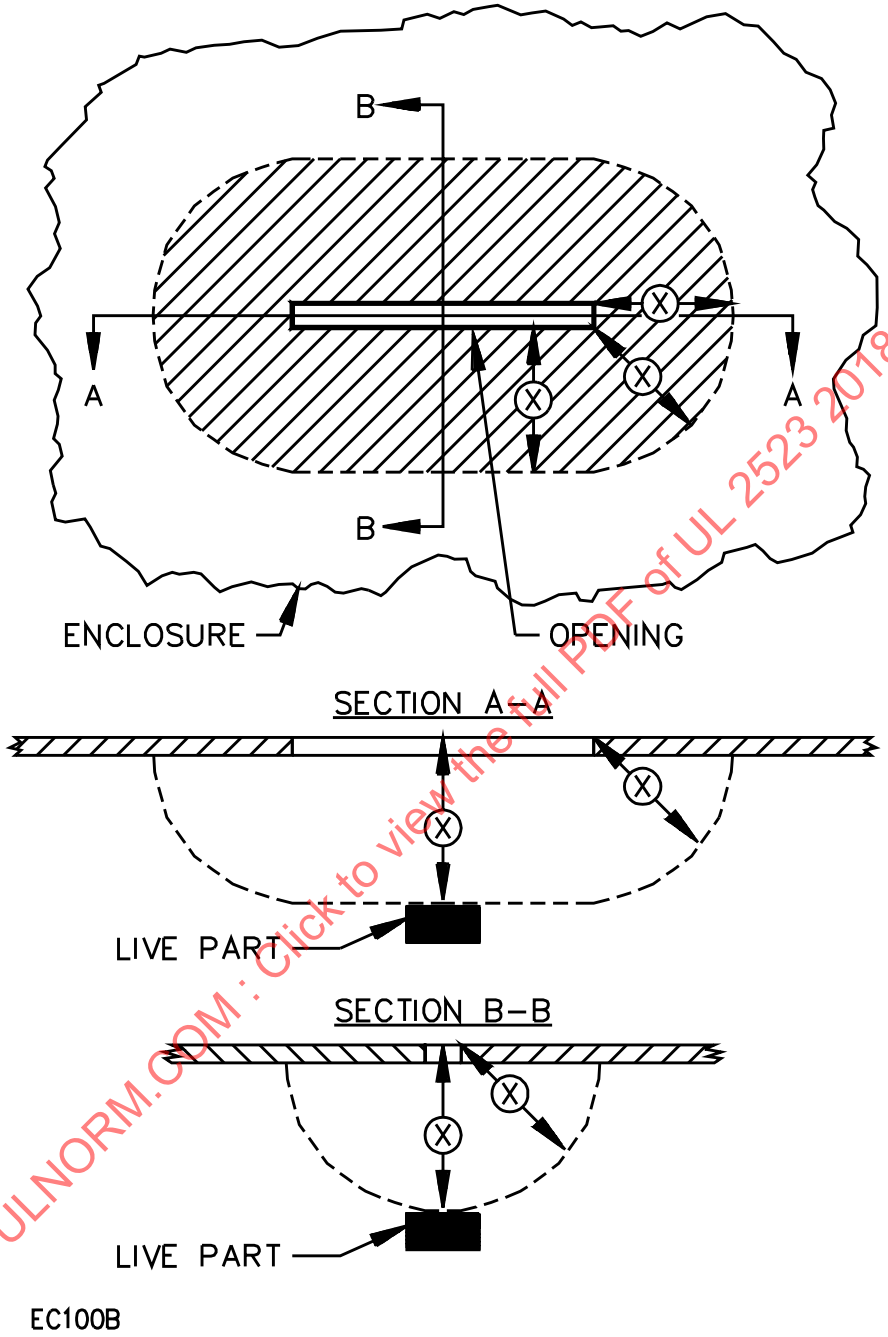


Figure 9.3
Opening in enclosure



The opening is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire:

a) Less than X inches (mm) from the perimeter of the opening, as well as

b) Within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm).