UL 296A

STANDARD FOR SAFETY

Waste Oil-Burning Air-Heating Appliances

UL Standard for Safety for Waste Oil-Burning Air-Heating Appliances, UL 296A

Third Edition, Dated August 2, 2018

Summary of Topics

This revision of ANSI/UL 296A dated November 2, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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 requirements are substantially in accordance with Proposal(s) on this subject dated August 11, 2023.

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UL 296A

Standard for Waste Oil-Burning Air-Heating Appliances

Previous numbered and unnumbered editions of standards covering heating appliances have been published since 1987.

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This ANSI/UL Standard for Safety consists of the Third Edition including revisions through November 2, 2023.

The most recent designation of ANSI/UL 296A as a Reaffirmed American National Standard (ANS) occurred on November 2, 2023. 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 ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

PART I – ALL WASTE OIL-BURNING AIR-HEATING APPLIANCES

INTRODUCTION

CONSTRUCTION

ELECTRICAL COMPONENTS

SPACINGS

PERFORMANCE

MANUFACTURING AND PRODUCTION TESTS

MARKINGS

INSTRUCTIONS

PART II – BURNERS

CONSTRUCTION

PERFORMANCE

PART III – BOILERS, FURNACES, AND HEATERS

CONSTRUCTION

PERFORMANCE – CENTRAL FURNACES

PERFORMANCE – UNIT HEATERS

PERFORMANCE – BOILERS

PART IV – OUTDOOR USE EQUIPMENT

CONSTRUCTION

PERFORMANCE

MARKING

APPENDIX A

No Text on This Page

PART I – ALL WASTE OIL-BURNING AIR-HEATING APPLIANCES

INTRODUCTION

1 Scope

1.1 These requirements cover air-heating appliances of the central furnace and unit heater types and boiler assemblies intended for burning waste oil fuels and having fuel inputs rated no more than 20 gallons/hour (75.7 liters/hour) or approximately 3,000,000 Btu/hour (3,160,000 kj/hour).

1.2 These requirements cover automatically-lighted, mechanical-atomizing type burners that typically are used with these appliances. The burner is to be factory-installed on or provided with each appliance.

1.3 The burners covered by these requirements are equipped with an automatic primary safety control to prevent the abnormal discharge of oil at the burner in the event of ignition failure or flame failure.

1.4 Requirements for the installation and use of waste oil-burning appliances are included in the Installation of Oil Burning Equipment, ANSI/NFPA 31. Waste oil-burning appliances are for use only in commercial and industrial applications.

1.5 In addition to being investigated for use with waste oils, the heating appliances covered by these requirements are investigated for use with a numerical grade of fuel oil, graded according to the Specification for Fuel Oils, ANSI/ASTM D396.

1.6 The terms "combustible" and "noncombustible", as used in these requirements, are defined in the Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances, ANSI/NFPA 97M.

2 General

2.1 The term "appliance" refers to any equipment covered by this standard. The term "furnace" refers to a central furnace. The term "heater" refers to a unit heater.

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

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

3 Glossary

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

3.2 ACCESSIBLE, READILY – Capable of being reached easily and quickly for operation, adjustment, and inspection.

3.3 AIR, PRIMARY – The air introduced into a burner and that mixes with the fuel before it reaches the ignition zone.

3.4 AIR, SECONDARY – The air externally supplied to the flame at or beyond the point of ignition.

3.5 AIR SHUTTER – An adjustable device for varying the size of the air inlet or inlets regulating primary or secondary air.

3.6 APPLIANCE, DIRECT VENT SYSTEM – A self-contained appliance that is inherently constructed so that:

a) All air supplied for combustion;

b) The combustion system of the appliance; and

c) All products of combustion

are completely isolated from the atmosphere of the space in which the appliance is installed.

3.7 APPLIANCE, VENTED – An indirect-fired appliance provided with a flue collar to accommodate a flue pipe for transporting flue gases to the outer air.

3.8 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.

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

3.10 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.

3.11 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).

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

3.13 BURNER, AUTOMATICALLY LIGHTED – One in which fuel to the main burner is normally turned on and ignited automatically.

3.14 BURNER, MANUALLY LIGHTED – One in which fuel to the main burner is turned on only by hand and is ignited under supervision.

3.15 BURNER, MECHANICAL-ATOMIZING TYPE – A power-operated burner that prepares and delivers the oil and all or part of the air by a mechanical process in controllable quantities for combustion. Some examples are air atomizing, high and low pressure atomizing, horizontal rotary atomizing, vertical rotary atomizing, and vertical rotary wall-flame burners.

3.16 BURNER, MECHANICAL-DRAFT TYPE – A burner that includes a power-driven fan, blower, or other mechanism as the principal means for supplying air for combustion.

3.17 BURNER, NATURAL-DRAFT TYPE – A burner that depends principally upon the natural draft created in the flue to induce into the burner the air required for combustion.

3.18 CONTROL, LIMIT – A safety control responsive to changes in liquid level, pressure, or temperature, normally set beyond the intended operating range of the controlled appliance to limit its operation.

3.19 CONTROL, OPERATING – A control, other than a safety control or interlock, to start or regulate input according to demand, and to stop or regulate input upon satisfaction of demand. An operating control may also actuate auxiliary equipment.

3.20 CONTROL, PRIMARY SAFETY – A control that is directly responsive to flame properties and that senses the presence or absence of flame and, in event of ignition failure or unintentional flame extinguishment, causes safety shutdown.

3.21 CONTROL, SAFETY – An 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, and injury to persons.

3.22 DRAFT REGULATOR, BAROMETRIC (AUTOMATIC DAMPER) – A device that functions to maintain a desired draft in the appliance by automatically reducing excess chimney draft to the desired value.

3.23 ELECTRICAL CIRCUITS:

a) High-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 (or an isolated limited secondary circuit);

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

c) Low-Voltage Circuit – A circuit involving a potential of no more than 30 volts rms alternating-current (42.4 volts peak) or direct current and:

1) Supplied by a Class 2 transformer, or by a battery, by a battery and fixed impedance, by a transformer and fixed impedance each of which complies with the requirements for a Class 2 transformer as specified in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3; or

2) Limited to a maximum of 100 volt-amperes. A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit to limit the voltage and current, is not considered to be a low-voltage circuit;

d) Safety Control Circuit – A circuit involving one or more safety controls.

3.24 EXCESS AIR – Air that passes through the combustion area and the appliance flues in excess of that which is theoretically required for complete combustion.

3.25 FLUE, APPLIANCE – The flue passages within the appliance.

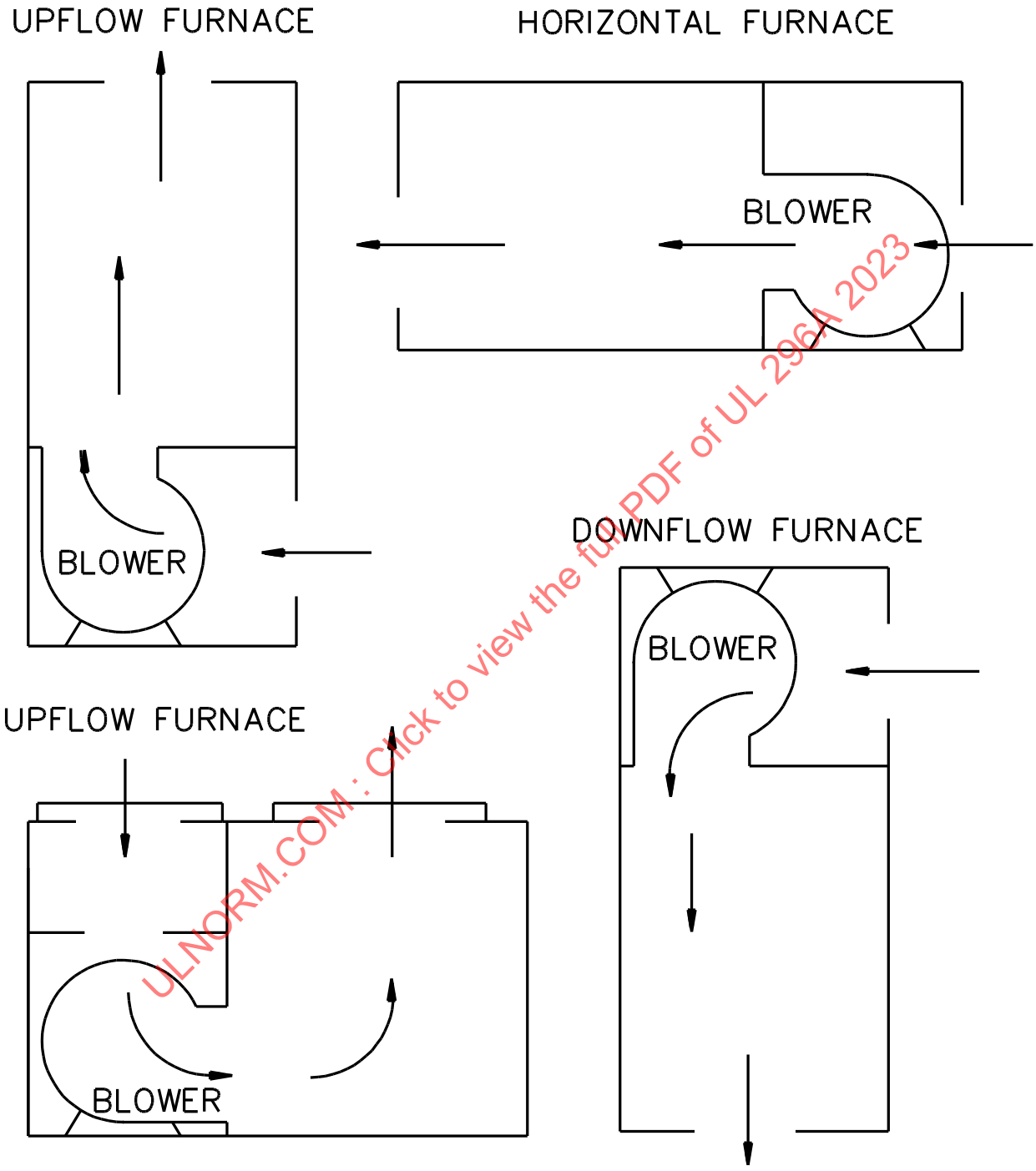
3.26 FLUE COLLAR – That portion of an appliance intended for attachment of the chimney or vent connector.

3.27 FURNACE, CENTRAL WARM-AIR – A self-contained indirect-fired appliance constructed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

3.28 FURNACE, DOWNFLOW – A forced-air type central furnace constructed with air flow through the furnace essentially in a vertical path, discharging air at or near the bottom of the furnace as shown in Figure 3.1.

Figure 3.1

Types of forced-air central furnaces



3.29 FURNACE, HORIZONTAL – A forced-air type central furnace constructed with air flow through the furnace essentially in a horizontal path as shown in Figure 3.1.

3.30 FURNACE, UPFLOW – A central furnace constructed with air flow through the furnace essentially in a vertical path, discharging air at or near the top of the furnace as shown in Figure 3.1.

3.31 IGNITION, INTERMITTENT – Ignition by an energy source that is continuously maintained throughout the time the burner is firing.

3.32 IGNITION, INTERRUPTED – An ignition system that is energized each time the main burner is to be fired and de-energized at the end of a timed trial-for-ignition period or after the main flame is established.

3.33 IGNITION, MANUAL – Ignition by an energy source that is manually energized and where the fuel to the pilot is lighted automatically when the ignition system is energized.

3.34 INTERLOCK – A control used to determine the physical state of a required condition and to signal that determination to the primary safety control of the appliance.

3.35 OIL, FUEL – Any hydrocarbon oil as defined by the Specifications for Fuel Oils, ANSI/ASTM D396.

3.36 OIL, WASTE – Used automotive crankcase oils (which may contain unburned gasoline, transmission fluids, or brake fluids). Waste oils may be a mixture of these fluids and may vary considerably in their chemical and physical properties.

3.37 PILOT – A flame that is used to ignite the fuel at the main burner or burners.

3.38 PILOT FLAME-ESTABLISHING PERIOD – The period of time fuel is permitted to be delivered to a proved pilot before the flame-sensing device is required to detect pilot flame.

3.39 PILOT, PROVED – A pilot flame supervised by a primary safety control that senses the presence of the pilot flame prior to permitting the main burner fuel to be delivered for combustion.

3.40 PUMP, OIL-TRANSFER – An oil pump, automatically or manually operated, that transfers oil through continuous piping from a supply tank to an oil-burning appliance or to an auxiliary tank and that is not intended to stop pumping automatically in case of total breakage of the oil supply line between the pump and the appliance.

3.41 RADIATION SHIELD – A separate panel or panels located between heating surfaces and adjacent objects to reduce heat transmission by radiation.

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

3.43 SERVICING – The periodic tasks performed to operate and maintain an appliance, such as air, fuel, pressure, and temperature regulation, cleaning, lubrication, and resetting of controls. Repair and replacement of parts other than those expected to be renewed periodically are not considered to be servicing tasks. Some examples of servicing are:

a) Cleaning or replacing nozzles, atomizers, and pilots;

b) Setting ignition electrodes;

c) Cleaning strainers or replacing strainer or filter element;

d) Resetting a safety control; and

e) Replacing an igniter cable.

3.44 SPECIAL PARTS AND TOOLS – Those parts and tools that are not generally available on the open retail market.

3.45 STRAINER, PRIMARY – The strainer through which all oil first passes on the way to the burner and that is located upstream from any other strainer.

3.46 STRAINER, SECONDARY – A strainer downstream from the primary strainer that is located in the fuel line between the primary strainer and the point at which fuel is delivered for combustion.

3.47 TRIAL-FOR-IGNITION PERIOD – The period of time the main burner fuel is permitted to be delivered into the ignition zone before the main flame-sensing device is required to detect main flame.

3.48 UNIT HEATER – A self-contained, automatically controlled, indirect-fired air heating appliance that may be floor-mounted or of the suspended type. A unit heater is equipped with an integral fan or blower for circulation of air and is to be used for the heating of a nonresidential space. A unit heater may be equipped with louvers or face extensions by the manufacturer.

3.49 VALVE, MANUAL OIL SHUT-OFF – A manually operated valve in the oil line for the purpose of completely turning on or shutting off the oil supply to the burner.

3.50 VALVE, OIL CONTROL – An automatically or manually operated device consisting essentially of an oil valve for controlling the fuel supply to a burner:

a) Metering (Regulating) Valve – An oil control valve for regulating burner input;

b) Safety Valve – A normally closed valve of the "on" and "off" type, without any bypass to the burner, that is actuated by a safety control or by an emergency device.

4 Components

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

4.2 A component 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.

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

4.4 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.

CONSTRUCTION

5 Protection of Users and Service Personnel

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

5.2 Service functions that 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 mechanisms;

c) Operating manual switches; or

d) Adjusting air-flow dampers.

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

5.3 The requirements specified in 5.1 are not applicable to mechanical service functions that are not normally performed with the equipment energized. Such functions include adjusting or replacing belts and cleaning and replacement of strainers and oil filters.

5.4 Adjustable or resettable electrical control or manual switching devices may be located or oriented with regard to uninsulated high-voltage live parts so that manipulation of the mechanism for adjustment, resetting, or operation can be accomplished in the intended direction of access if uninsulated high-voltage live parts or moving parts that may cause injury to persons are not located:

a) In front of the mechanism in the direction of access; and

b) Within 6 inches (152 mm) on any side or behind the mechanism, unless guarded.

5.5 An electrical control component that may require examination, adjustment, servicing, or maintenance while energized (excluding voltage measurements other than for jacks or terminals specifically intended for that purpose) shall be located and mounted with regard to other components and with regard to grounded metal parts so that the component is accessible for electrical service functions without subjecting service personnel to:

a) The risk of electric shock from adjacent uninsulated live parts; or

b) Injury from adjacent moving parts.

5.6 Accessibility and protection from the risk of electric shock and accidental contact with moving parts that may cause injury to persons may be accomplished by mounting the control components in an assembly so that unimpeded access is provided to each compartment through an access cover or panel in the outer cabinet or the cover of the control assembly enclosure, as shown in Figure 5.1, with the following arrangement:

a) The components are located with regard to the access opening in the outer cabinet so that the component in the control assembly that is located farthest from the access opening is no more than 14 inches (356 mm) from the plane of the access opening;

b) Uninsulated high-voltage live parts outside the control assembly projected clear space (except for live parts within a control panel) or unguarded moving parts are located at least 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 the assembly; and

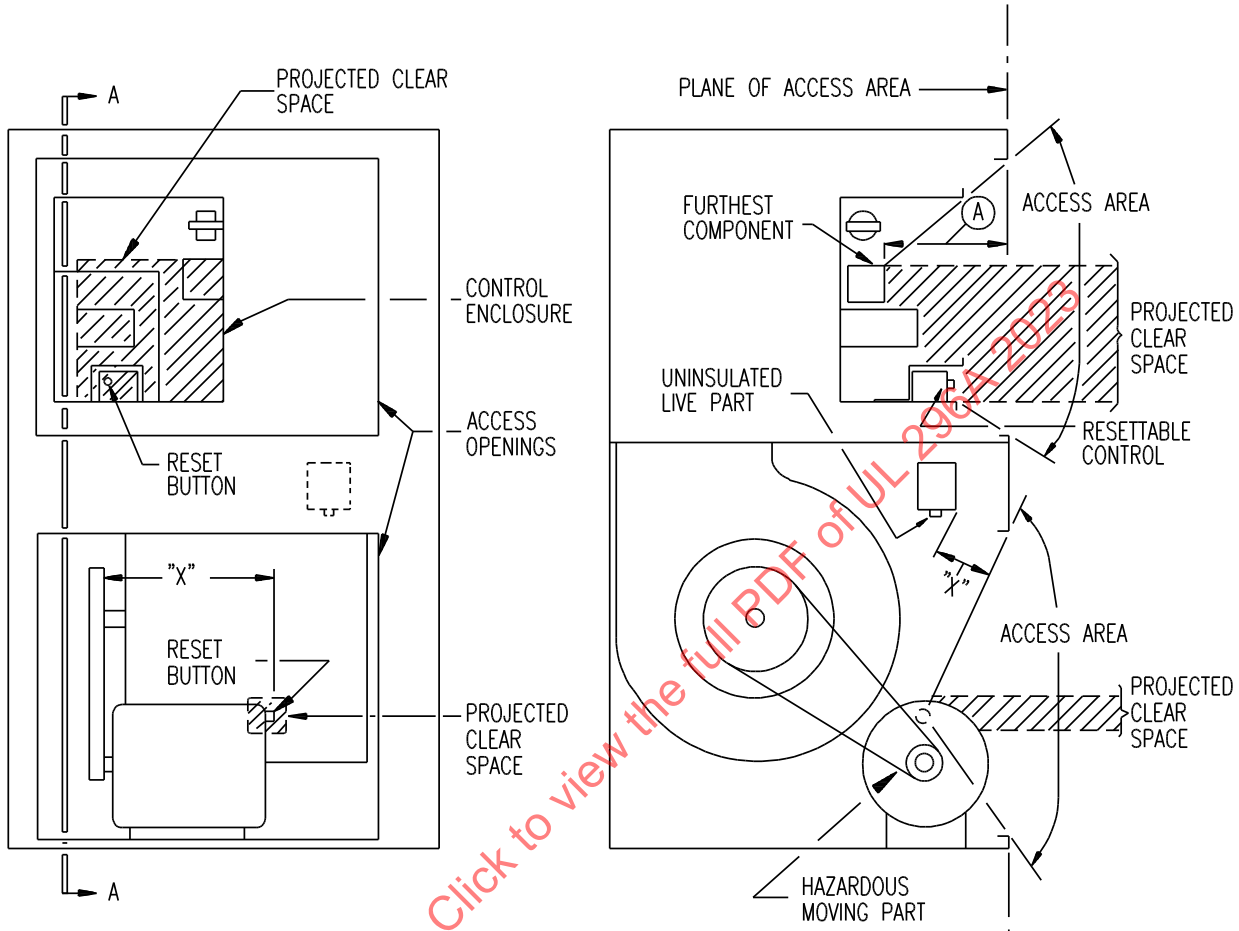
e) Extractor-type fuseholders and snap switches mounted through the control assembly enclosure are to be located so that:

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 as specified in 5.4, unless guarded.

Figure 5.1

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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5.7 Components in a low-voltage circuit shall comply with the requirements specified in 5.5 in their relation to uninsulated live parts in a high-voltage circuit and to moving parts.

5.8 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 wire.

5.9 Moving parts such as fan blades, blower wheels, pulleys, or belts that may cause injury to persons shall be enclosed or guarded.

5.10 If the removal of doors, panels, or shields will expose moving parts:

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

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

c) A warning marking as specified in 34.6 shall be provided where readily visible after installation to warn the user to shut off the equipment before removing or opening the cover or door.

5.11 The distance from an opening in a required guard or enclosure to the moving part indicated in 5.9 shall be in accordance with Table 5.1, and the minor dimension of the opening shall not in any case exceed 3 inches (76.2 mm). For an opening having a minor dimension between two of the values included in Table 5.1, the distance from the opening to the moving part shall be no less than that found by interpolation between the corresponding values in the right-hand column of the table. The minor dimension of the opening shall be determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22 N).

Table 5.1
Dimensions of openings in enclosure

Minor dimensions of opening[a]		Minimum distance from opening to moving part	
Inches	(mm)	Inches	(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)
1-1/2	(38.1)	10-1/2	(267)
2	(50.8)	14-1/2	(368)
3	(76.2)	30	(762)

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

5.12 If a moving part is unlikely to be contacted through the opening because of fixed components, including baffles, the moving part shall not be considered when determining compliance with 5.1 and 5.9.

6 Enclosures

6.1 General

6.1.1 Uninsulated high-voltage live parts shall be enclosed or guarded to reduce the risk of unintentional contact by persons during intended use of the equipment. This applies also to uninsulated high-voltage live parts located in a compartment into which access is required for servicing of the equipment, such as resetting controls, replacing filters, lubrication, and cleaning.

6.1.2 Among the factors taken into consideration when determining the acceptability of an enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of intended or abnormal use.

For a nonmetallic enclosure or nonmetallic part of an enclosure, all of these factors shall be considered with regard to thermal and chemical aging.

6.1.3 The enclosure shall prevent the emission of molten metal, burning insulation, flaming particles, or the like through openings onto flammable material, including the surface on which the equipment is mounted.

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

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

6.1.6 Sheet metal complying with Table 6.1 or Table 6.2, whichever is appropriate, is acceptable for the individual enclosure of electrical components.

6.1.7 If the construction and location of the component and the strength and rigidity of the outer cabinet warrant, an individual enclosure of metal thinner than as specified in Table 6.1 or Table 6.2, whichever is applicable, may be used.

6.1.8 If insulating material other than electrical insulation is provided within the enclosure, the burning characteristics and flammability of the material and the proximity of an ignition source shall be considered.

6.1.9 Each intended mounting position of the unit shall be considered when determining if the unit complies with the requirement specified in 6.1.3.

6.1.10 A junction box that is formed in part 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 greater than 1/2 inch (12.7 mm) does not permit the entrance of a flat feeler gauge that is 5/64 inch (2.0 mm) thick by 1/2 inch (12.7 mm) wide; and

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

Table 6.1
Minimum thickness of sheet metal for electrical enclosures carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b] in		Maximum length[c] in		Maximum width[b] in		Maximum length in		Uncoated		Zinc coated	
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Inch	(mm)	Inch	(mm)
4.0	(10.2)	Not limited		6.25	(15.9)	Not Limited		0.020[d]	(0.51)	0.023[d]	(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[d]	(0.66)	0.029[d]	(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)
38.0	(96.5)	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 that may be applied by the enclosure surface when it is deflected. An enclosure that is considered to have equivalent reinforcing may be accomplished by constructions that will produce a structure that is as rigid as one built with a frame of angles or channels. Constructions considered to be without a supporting frame include, a single sheet with single formed flanges (formed edges), a single sheet that is corrugated or ribbed, and 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 that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For a panel that is not supported along one side, such as a side panel of a box, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

[d] Sheet metal 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 electrical enclosures carbon steel or stainless steel

Without supporting frame[a]				With supporting frame equivalent reinforcing[a]					
Maximum width[b] in		Maximum length[c] in		Maximum width[b] in		Maximum length in		Minimum thickness	
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Inch	(mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023[d]	(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 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 that may be applied by the enclosure surface when it is deflected. An enclosure that is considered to have equivalent reinforcing may be accomplished by constructions that will produce a structure that is as rigid as one built with a frame of angles or channels. Constructions considered to be without a supporting frame include, single sheet with formed flanges (formed edges), a single sheet that is corrugated or ribbed; and 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 that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For a panel not supported along one side, such as a side panel of a box, the length of the unsupported side shall be limited to the dimensions specified. unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

[d] Sheet metal for an enclosure intended for outdoor use shall comply with the requirements for outdoor use equipment.

6.1.11 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with one of the following:

a) For an opening that has a minor dimension, as defined in 6.1.15, less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 6.1; and

b) For an opening that has a minor dimension of 1 inch or greater, such a part or wire shall be spaced from the opening as specified in Table 6.3.

Exception: An opening in an integral enclosure of a motor need not comply with these requirements if it complies with the requirements specified in 6.1.12.

Table 6.3
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

Minor dimension[a] of opening		Minimum distance from opening to part	
Inches[b]	(mm)[b]	Inches	(mm)
3/4	(19.1)[c]	4-1/2	(114.0)
1[c]	(25.4)[c]	6-1/2	(165.0)
1-1/4	(31.8)	7-1/2	(191.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(445.0)
d		30	(762.0)

[a] See 6.15.

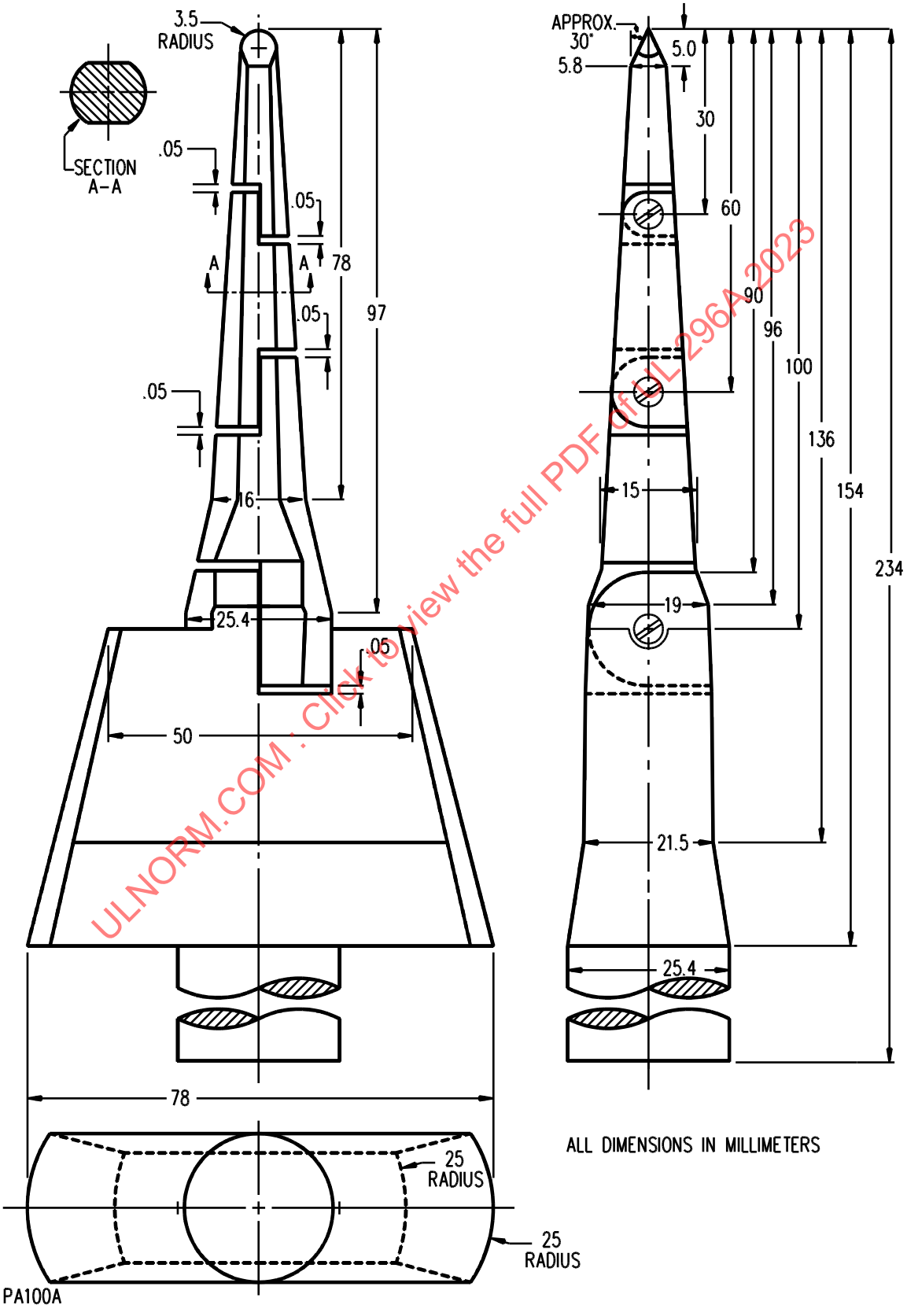
[b] Between 3/4 and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 inch applies to a motor only.

[d] More than 2-1/8 inches, but no more than 6 inches (152 mm).

Figure 6.1

Articulate probe with web stop



6.1.12 With regard to a part or wire as specified in 6.1.11, for an integral enclosure of a motor as specified in the exception of 6.1.11:

a) An opening that has a minor dimension, as defined in 6.1.15, less than 3/4 inch (19.1 mm) is acceptable if:

1) Film-coated wire cannot be contacted by the probe illustrated in Figure 6.2;

2) In a directly accessible motor as specified in 6.1.16, an uninsulated live part cannot be contacted by the probe illustrated in Figure 6.3; or

3) In an indirectly accessible motor as specified in 6.1.16, an uninsulated live part cannot be contacted by the probe illustrated in Figure 6.4;

b) An opening that has a minor dimension of 3/4 inch or greater is acceptable if a part or wire is spaced from the opening as specified in Table 6.3.

Figure 6.2

Probe for film-coated wire

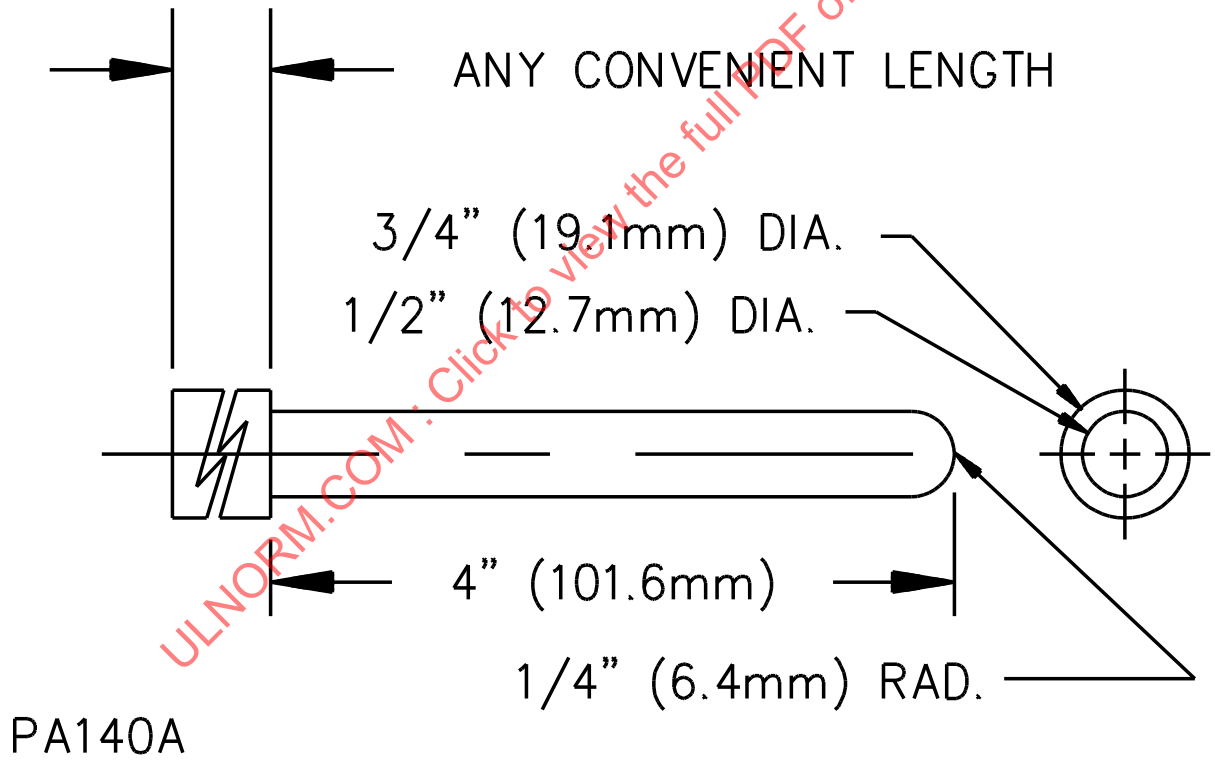


Figure 6.3

Articulate probe

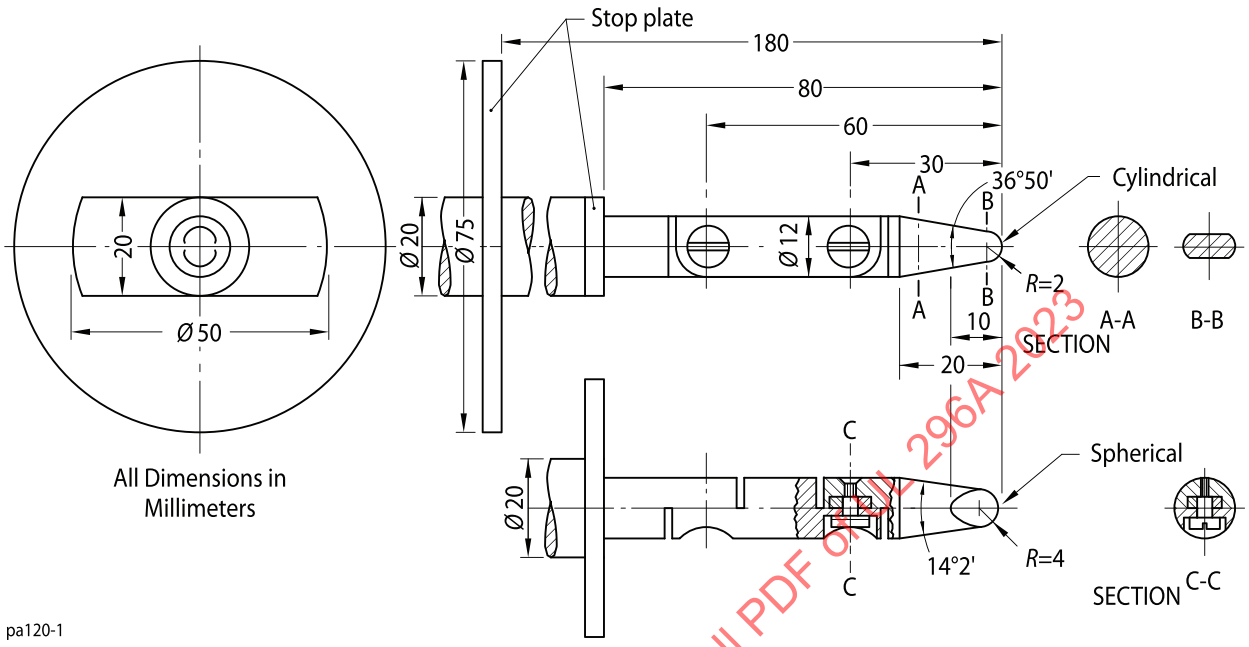
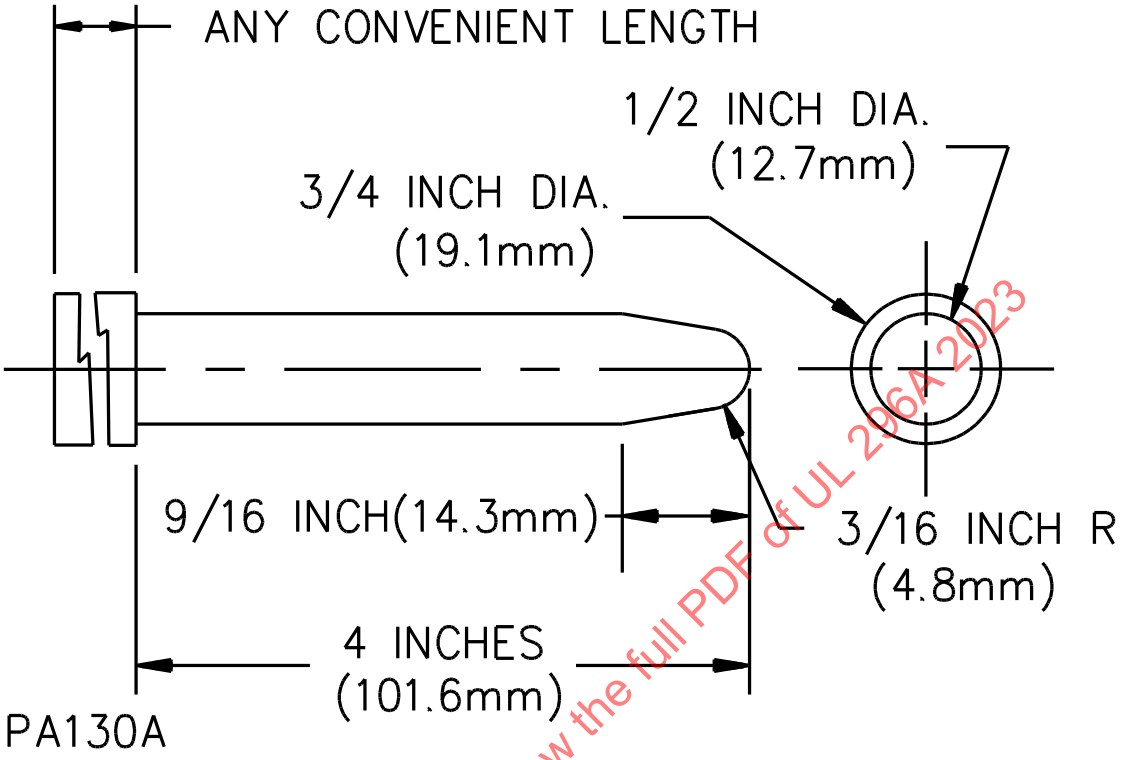


Figure 6.4

Probe for uninsulated live parts



6.1.13 The probes specified in 6.1.11 and 6.1.12 and illustrated in Figure 6.1 – Figure 6.4 shall be applied to any depth that the opening will permit and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figure 6.1 and Figure 6.3 shall be applied in any possible configuration and, if necessary, the configuration shall be changed after insertion through the opening.

6.1.14 The probes specified in 6.1.13 and 6.1.15 shall be used as measuring instruments to judge the accessibility provided by an opening and not as instruments to judge the strength of a material; the probes are to be applied with the minimum force necessary to determine accessibility.

6.1.15 With regard to the requirements specified in 6.1.11 and 6.1.12, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

6.1.16 With regard to the requirements specified in 6.1.12, an indirectly accessible motor is a motor that:

a) Is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool; or

b) Is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted. A directly accessible motor is a motor that:

1) Can be contacted without opening or removing any part; or

2) Is located so as to be accessible to contact.