



UL 778

STANDARD FOR SAFETY

Motor-Operated Water Pumps

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UL Standard for Safety for Motor-Operated Water Pumps, UL 778

Fifth Edition, Dated February 22, 2010

Summary of Topics

This revision of ANSI/UL 778 includes the following changes in requirements:

- 1. Clarification of the Scope of the Standard***
- 2. Clarification of Requirements for Supply Cord Termination in Paragraph 13.1.2***
- 3. Revision of Requirements in Section 13.8***
- 4. Addition of Requirements for Elevator Hoistway Sump Pumps***
- 5. Clarification of Requirements for Equipment Grounding in Paragraphs 18.1.2 and 18.2.9***
- 6. The Inclusion of Temperature Limits Instead of Temperature Rises for the Temperature Test in Section 35***
- 7. Revision of Instructions for Cord Requirements for Pumps Intended for Use With Portable Fountains in Paragraph 56.4***
- 8. Revision of Requirements for Fountain Pumps with Low-Voltage Luminaires in Paragraph 60.1***
- 9. Addition of Supplemental Requirements for Pumps Intended for Installation in Environmental Air Handling Spaces (Plenums)***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated December 16, 2011 and March 23, 2012.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

The following table lists the future effective dates with the corresponding reference.

Future Effective Date	Reference
November 25, 2013	Paragraph 56.4

FEBRUARY 22, 2010
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Fifth Edition

February 22, 2010

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through May 25, 2012.

The most recent designation of ANSI/UL 778 as an American National Standard (ANSI) occurred on May 25, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

The Department of Defense (DoD) has adopted UL 778 on March 11, 1991. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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 <http://csds.ul.com>.

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PART 1 – ALL SUBMERSIBLE AND NON-SUBMERSIBLE MOTOR-OPERATED PUMPS

INTRODUCTION

1 Scope

1.1 These requirements cover submersible and nonsubmersible motor-operated pumps intended to be used in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover pumps rated more than 600 volts, pumps using universal motors rated more than 250 volts, pumps for fire protection service, pumps for use as or with swimming or wading pool equipment, therapeutic baths, and similar equipment, nor pumps covered by other individual requirements. These requirements do not cover pressure controls or pressure tanks that are intended for use in water or other liquid systems. These requirements do not cover pumps intended for corrosive or flammable fluids. These would include but not be limited to gasoline, kerosene, oil, chemicals, and pesticides.

1.2 revised May 25, 2012

1.3 A pump not covered by any of the definitions in Definitions, Section 3, and a pump intended for use with liquids other than water, shall be evaluated on the basis of its compliance with the requirements in this standard, and further examination and tests required to determine whether it is acceptable for the purpose. This would include but not be limited to pumps intended for water/glycol and similar mixtures intended for use in hot water radiant heating or thermal solar applications.

1.3 revised May 25, 2012

2 General

2.1 Components

Section 2.1 revised and relocated as Section 5A.1 January 14, 2011

2.1.1 Revised and relocated as 5A.1.1 January 14, 2011.

2.1.2 Revised and relocated as 5A.1.2 January 14, 2011.

2.1.3 Relocated as 5A.1.3 January 14, 2011.

2.1.4 Relocated as 5A.1.4 January 14, 2011.

2.2 Units of measurement

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

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

2.3 Undated references

2.3.1 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.

3 Definitions

3.1 For the purpose of these requirements, the following definitions apply.

3.2 CONDENSATE PUMP – A pump intended for use with equipment to facilitate the removal of water condensate.

3.3 CORD-CONNECTED PUMP – A pump intended to be connected to a branch circuit supply by means of flexible cord and an attachment plug.

3.4 DEEP-WELL PUMP – A permanently installed, submersible or nonsubmersible pump intended to be used for pumping water from a well for irrigation and other agricultural purposes; for domestic, municipal, and industrial water supplies; and the like.

3.5 EFFLUENT PUMP – A pump intended to pump liquid forms of waste mixed with water.

3.5.1 ELEVATOR HOISTWAY SUMP PUMP – A submersible pump installed in elevator pits intended for the removal of accumulated (accidental) water. They are not intended for the removal of accumulated oils and/or hazardous materials.

3.5.1 added May 25, 2012

3.6 ENCLOSURE – That part of the product that:

a) Renders inaccessible all or any parts of the equipment that may otherwise present a risk of electric shock and/or

b) Retards propagation of flame initiated by electrical disturbances occurring within.

3.7 FIELD-WIRING TERMINAL – A terminal to which power supply (including equipment grounding) or control connection will be made in the field when the product is installed as intended. If the wire to be connected to the terminal is provided as part of the unit, and a pressure terminal, connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire, it is not a field-wiring terminal.

3.8 FOUNTAIN PUMP – A pump intended for use with a fountain.

3.8.1 INDUSTRIAL USE – Pumps intended for industrial use are those with constructions meeting the following parameters:

- a) Are intended to be field installed in accordance with Article 430 of ANSI/NFPA 70, National Electrical Code (NEC);
- b) Are intended for three-phase supply sources; and
- c) Where the motor overtemperature protection required by Part III of Article 430 of the NEC is intended to be provided by a separate overload device or control.

3.8.1 added January 14, 2011

3.9 IRRIGATION PUMP – A pump intended to be used directly or indirectly for irrigation to pump water from a surface or a subsurface source, or from a treatment facility to the point of application.

3.10 JET PUMP – A well pump with the driving unit at ground surface level that returns a portion of the water through an ejector submerged or within the normal suction-lift distance of the water.

3.11 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.

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3.12 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of no more than 42.4 volts supplied by a battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with the performance requirements for Class 2 transformers. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit, as a means of limiting the voltage and current is not considered to be a low-voltage circuit.

3.13 OPPOSITE POLARITY – A difference of potential between two points, where shorting of these two points would result in a condition involving overload, rupturing of printed wiring-board tracks, components or fuses, and the like.

3.14 PERMANENTLY INSTALLED PUMP – A pump intended for connection to fixed plumbing, or intended to be mechanically-mounted or fastened in a permanent manner.

3.15 PORTABLE PUMP – A cord-connected pump with no provision for permanent mounting or for connection to fixed plumbing, and intended to be moved from place to place frequently, such as contractor and utility pumps.

3.16 PRIMARY CIRCUIT – The wiring and components that are conductively connected to the branch circuit.

3.17 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist at any part when:

- a) The potential between the part and earth ground or any other accessible part is more than 42.4 V peak and
- b) The continuous current flow through a 1500-ohm resistor connected across the potential exceeds 0.5 mA.

3.18 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

- a) The open circuit voltage is more than 42.4 V peak and the energy available to the circuit under any condition of load including short circuit results in a current of 8 A or more after 1 minute of operation or
- b) A power of more than 15 watts can be delivered into an external resistor connected between the two points.

3.19 SECONDARY CIRCUIT – A circuit that is conductively connected to the secondary winding of an isolating transformer.

3.20 SEWAGE PUMP – A pump intended to pump sewage consisting of solid wastes mixed with water.

3.21 SHALLOW-WELL PUMP – A surface-mounted pump, jet or other, with limited suction-lift capability.

3.22 SUBMERSIBLE CONTRACTOR PUMP – A submersible pump connected to its controls by lengths of water-resistant flexible cable, intended for temporary use near or on a construction site.

3.23 SUBMERSIBLE PUMP – A pump that is intended to operate with its motor submerged in water.

3.24 SUMP PUMP – A pump intended to be installed in a sump or wet location where drainage collects.

3.25 WATER-CIRCULATING PUMP – A pump intended for permanent installation in a plumbing system that may or may not handle heated water.

3.26 UTILITY PUMP – A cord-connected pump moved from place to place frequently.

4 Instructions Provided With the Pump

4.1 With reference to the requirement in 3.1, the literature accompanying a pump and covering its intended uses shall be considered in determining its category.

CONSTRUCTION

5 General

5.1 A pump shall use materials found by investigation to be acceptable for the intended application.

5.2 A pump shall be acceptable for both indoor and outdoor use unless marked as specified in 53.6.

5A Component Specifications

5A added January 14, 2011

5A.1 Components

Section 2.1 revised and relocated as Section 5A.1 January 14, 2011

5A.1.1 Except as indicated in 5A.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

2.1.1 revised and relocated as 5A.1.1 January 14, 2011

5A.1.2 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.
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

2.1.2 revised and relocated as 5A.1.2 January 14, 2011

5A.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.3 relocated as 5A.1.3 January 14, 2011

5A.1.4 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.

2.1.4 relocated as 5A.1.4 January 14, 2011

5A.1.5 Components shall be suitable for the intended use and installation environment. This suitability shall assume the following installation parameters as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840:

- a) Pollution Degree III installations.
- b) Overvoltage Category II.

5A.1.5 added January 14, 2011

5A.1.6 Components not anticipated by the requirements of this Standard, not specifically covered by a component standard as indicated in this Section, and which pose a potential risk of electric shock, fire or casualty hazard shall be additionally investigated. Reference to other product standards is appropriate where those standards anticipate normal and abnormal use conditions consistent with the application of this Standard.

5A.1.6 added January 14, 2011

5A.2 Fuses

5A.2 added January 14, 2011

5A.2.1 Fuses specified in 24.5 shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and any of the associated Part 2 Standards listed below, as applicable for the type of fuse:

- a) The Standard for Low-Voltage Fuses – Part 2: Class C Fuses, UL 248-2; or
- b) The Standard for Low-Voltage Fuses – Part 3: Class CA and CB Fuses, UL 248-3; or
- c) The Standard for Low-Voltage Fuses – Part 4: Class CC Fuses, UL 248-4; or
- d) The Standard for Low-Voltage Fuses – Part 5: Class G Fuses, UL 248-5; or
- e) The Standard for Low-Voltage Fuses – Part 6: Class H Non-Renewable Fuses, UL 248-6; or
- f) The Standard for Low-Voltage Fuses – Part 7: Class H Renewable Fuses, UL 248-7; or
- g) The Standard for Low-Voltage Fuses – Part 8: Class J Fuses, UL 248-8; or
- h) The Standard for Low-Voltage Fuses – Part 9: Class K Fuses, UL 248-9; or
- i) The Standard for Low-Voltage Fuses – Part 10: Class L Fuses, UL 248-10; or
- j) The Standard for Low-Voltage Fuses – Part 11: Plug Fuses, UL 248-11; or
- k) The Standard for Low-Voltage Fuses – Part 12: Class R Fuses, UL 248-12; or
- l) The Standard for Low-Voltage Fuses – Part 15: Class T Fuses, UL 248-15.

5A.3 Fuseholders

5A.3 added January 14, 2011

5A.3.1 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, in conjunction with any of the associated Part 2 Standards listed below, as applicable for the type of fuse:

- a) The Standard for Fuseholders – Part 4: Class CC, UL 4248-4; or
- b) The Standard for Fuseholders – Part 5: Class G, UL 4248-5; or
- c) The Standard for Fuseholders – Part 6: Class H, UL 4248-6; or
- d) The Standard for Fuseholders – Part 8: Class J, UL 4248-8; or
- e) The Standard for Fuseholders – Part 9: Class K, UL 4248-9; or
- f) The Standard for Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse, UL 4248-11; or
- g) The Standard for Fuseholders – Part 12: Class R, UL 4248-12; or
- h) The Standard for Fuseholders – Part 15: Class T, UL 4248-15.

5A.4 Printed wiring boards

5A.4 added January 14, 2011

5A.4.1 Printed wiring boards shall comply with the Standard for Printed-Wiring Boards, UL 796. A printed wiring board shall have a temperature rating corresponding to the maximum temperature on the board during the Temperature Test, Section 35. Unless wholly in a Class 2 circuit, it shall comply with the direct support of live parts requirements in UL 796.

5A.5 Quick-connect wire connectors

5A.5 added January 14, 2011

5A.5.1 Quick-connect type wire connectors shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated, they shall be rated for the voltage and temperature of the intended use. They shall be applied per the installation instructions of the wire connector manufacturer.

5A.5.2 Quick-connect type wire connectors shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

5A.6 Terminal blocks

5A.6 added January 14, 2011

5A.6.1 Terminal blocks shall comply with:

- a) The Standard for Terminal Blocks, UL 1059; or
- b) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-1: Ancillary Equipment – Terminal Blocks for Copper Conductors, UL 60947-7-1; or
- c) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-2: Ancillary Equipment – Protective Conductor Terminal Blocks for Copper Conductors, UL 60947-7-2; or
- d) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-3: Ancillary Equipment – Safety Requirements for Fuse Terminal Blocks, UL 60947-7-3.

5A.6.2 The UL 60947-7 Series Standards specified in 5A.6.1 (b) – (d) are used in conjunction with the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1.

5A.6.3 Terminal blocks shall be suitable for the number of conductors per termination, wire size, type (solid or stranded), conductor material (copper or aluminum), voltage and current of the intended use.

5A.7 Wire connectors

5A.7 added January 14, 2011

5A.7.1 Wire connectors shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated they shall be suitable for the voltage and current of the intended use. They shall be applied per the installation instructions of the wire connector manufacturer.

5A.7.2 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B, or the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

6 Adhesives Used to Secure Parts

6.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.2 The requirement in 6.1 also applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

- a) Energize an accessible dead metal part,
- b) Make a live part accessible,
- c) Reduce spacings below the minimum acceptable values, or
- d) Short-circuit live parts.

7 Enclosure

7.1 A pump shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without creating a risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.2 An electrical part shall be enclosed without depending upon a mounting surface or niche to complete the enclosure.

7.3 When an enclosure containing motor coils, internal splices, starting switches, starting relay coils, capacitors, or other live parts is intended to be submerged, such parts shall be enclosed in a watertight compartment or encapsulated in an acceptable insulating system. When the encapsulation also serves as the enclosure, live parts shall be at least 1/8 inch (3.2 mm) from the surface of the encapsulation.

7.4 A one-piece, molded coil form in contact with water shall have a wall thickness of at least 1/32 inch (0.8 mm).

7.5 For an unreinforced, flat surface in general, cast metal shall be no less than 1/8 inch (3.2 mm) thick, except that malleable iron may be no less than 3/32 inch (2.4 mm) and die-cast metal may be no less than 5/64 inch (2.0 mm) thick. Corresponding thicknesses of no less than 3/32, 1/16 (1.6 mm), and 3/64 inch (1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that the necessary mechanical strength is provided.

7.6 An enclosure of sheet metal shall be evaluated with regard to its size, shape, thickness of metal, and acceptability for the application. Uncoated sheet steel less than 0.026 inch (0.6 mm) thick, galvanized sheet steel less than 0.029 inch (0.74 mm) thick, sheet aluminum less than 0.036 inch (0.91 mm) thick, and sheet copper or sheet brass less than 0.033 inch (0.84 mm) thick shall not be used other than in relatively small areas or for surfaces that are curved, ribbed, or otherwise reinforced.

7.7 Sheet-metal to which a wiring system is to be connected in the field shall not be less than 0.032 inch (0.81 mm) thick if uncoated steel, 0.034 inch (0.86 mm) thick if galvanized steel, 0.044 inch (1.2 mm) thick if aluminum sheet, and 0.043 inch (1.09 mm) thick if copper or brass sheet.

7.8 A sheet-steel enclosure intended for outdoor use shall not be less than 0.032 inch (0.81 mm) thick if uncoated, and 0.034 inch (0.86 mm) thick if galvanized.

7.9 Among the factors considered when evaluating the acceptability of a nonmetallic enclosure or an enclosure of magnesium shall be its:

- a) Mechanical strength and rigidity,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Flammability,
- e) Resistance to distortion at temperatures to which the material may be subjected under conditions of actual use, and
- f) Resistance to ignition.

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7.10 When determining compliance with the enclosure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, a polymeric (including epoxy potting compounds) enclosure shall comply with the following:

- a) Material Properties – The material shall comply with the “Material property considerations” table in UL 746C.
- b) Impact Test – A minimum impact of 5 ft-lbf (6.8 J) shall apply to all enclosure materials. In addition to the test requirements specified in UL 746C, any cracking of a polymeric material that would be exposed to water is considered unacceptable. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.
- c) Abnormal Operations – See the Abnormal Operation Test, Section 48.
- d) Mold-Stress Relief Distortion – In addition to the test requirements specified in UL 746C, any cracking of a polymeric material that is exposed to water is considered unacceptable. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.
- e) Strain Relief – This test is only required when the strain-relief means is secured to the enclosure or is an integral part of the polymeric enclosure.
- f) UV Resistance – This test is only required when the equipment is intended for outdoor use. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.
- g) Flammability – Minimum flammability rating of polymeric enclosures shall be 5VA, 5VB, V-0, V-1, V-2 for portable pumps and 5VA for all other types of pumps.
- h) Water Exposure and Immersion – Polymeric materials shall comply with UL 746C.
- i) Dimensional Stability – Polymeric materials shall comply with UL 746C.
- j) Conduit Connections – Products permanently connected electrically shall comply with the requirements in UL 746C.

7.11 An enclosure of a pump shall reduce the risk of molten metal, burning insulation, flaming particles, or the like, from falling outside the enclosure or upon material that may be flammable, such as the surface upon which the pump rests or is supported.

7.12 The requirement in 7.11 necessitates the use of a barrier or pan of nonflammable material under a motor unless:

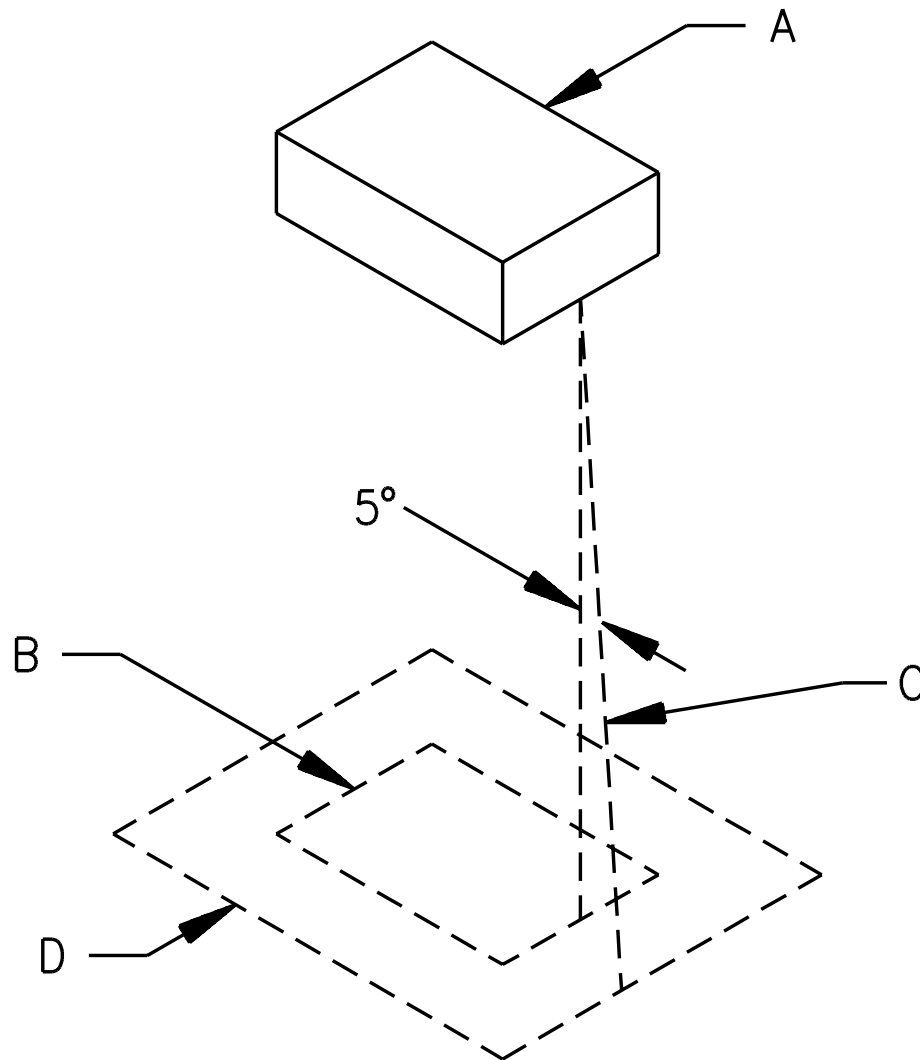
- a) The structural parts of the pump or motor provide the equivalent of such a barrier;
- b) The overload protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the pump when the motor is energized under open main winding, open start winding, starting-switch short circuit, or split-phase motor capacitor short-circuit conditions; or
- c) The motor complies with the requirements for impedance-protected motors in the Standard for Overheating Protection for Motors, UL 2111, and is rated for the application.

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7.13 The barrier required in 7.12 shall be horizontal or constructed to provide equivalent protection, located as illustrated in Figure 7.1, and shall be not smaller in area than indicated in that figure. Openings for drainage, ventilation, and the like, may be used in the barrier when they are protected by a baffle, a screen, or the like, so that molten metal, burning insulation, and the like, cannot fall outside the enclosure.

Figure 7.1
Location and extent of barrier



SA0604

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded, and will 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 which traces out minimum area of barrier. When moving, the line is always:

- 1) Tangent to the component,
- 2) 5 degrees from the vertical, and
- 3) Oriented so that the area traced out on a horizontal plane is maximum.

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

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7.14 An opening in the enclosure of an outdoor-use pump or control shall be located or baffled so that rain will not enter the opening.

7.15 An enclosure for electrical components of a nonsubmersible outdoor-use pump or control shall be provided with a drain hole at least 1/8 inch (3.2 mm) in diameter or an opening providing equivalent drainage.

7.16 A panel or cover in the enclosure of an outdoor-use pump, or a control that must be removed or opened for routine maintenance of the pump, shall be attached to the enclosure when open or removed. Removal of such a panel or cover shall require the use of one or more tools.

7.17 A door or cover on an enclosure that gives access to an overload-protective device that requires resetting or renewal shall be hinged, pivoted, or equivalently attached, and shall be held normally closed or be provided with a positive latch.

8 Parts in Contact with Potable Water

8.1 A part of a pump in contact with potable water shall be of a nontoxic, corrosion-resistant material consistent with industry plumbing practice.

9 Provision for Servicing

9.1 A submersible sump pump, a submersible well pump, or a submersible contractor pump shall be provided with a means to permit removal from a sump, a well, or a pit by means other than pulling on the power-supply cord, cable, or on the discharge pipe.

Exception: A submersible pump intended to utilize the power-supply cord or a segment of the cord for such use need not comply with this requirement.

10 Mechanical Assembly

10.1 A pump shall be assembled so that it will not be adversely affected by the vibration of normal operation. See Polymeric Motor Supports, Section 28.

10.2 A switch, a lampholder, a receptacle, a plug connector, and similar components shall be secured and shall be prevented from turning by means other than friction alone between surfaces.

Exception No. 1: A switch need not be prevented from turning if all of the following conditions are met:

- a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during the normal operation of the switch.*
- b) Means for mounting the switch makes it unlikely that operation of the switch will loosen it.*
- c) Normal operation of the switch is by mechanical means rather than directly by a person.*
- d) Spacings are not reduced below the minimum acceptable values if the switch rotates, and neither a lead nor a connection thereto is stressed.*

Exception No. 2: A mercury switch that must move to operate and complies with Exception No. 1(d).

10.3 A switch shall be guarded or mounted in a location where it is not likely to be damaged during normal use of the pump.

10.4 A brush holder or a brush cap in a commutator motor shall be constructed to prevent loosening, and shall be located so as to reduce the likelihood of damage. A close-fitting threaded external tooth brush cap is acceptable.

10.5 A brush and holder of a cord-connected pump shall be constructed so that, in the event of brush wearout, the brush follower, the spring lead end, or other parts cannot leave the brush holder or reduce spacings to noncurrent-carrying metal parts.

11 Protection Against Corrosion

11.1 An iron or steel part shall be protected against corrosion by enameling, painting, galvanizing, plating, or an equivalent means if corrosion of such a part would result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: This requirement does not apply in certain instances where oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable, thickness of metal and temperature also being factors.

Exception No. 2: The requirement for corrosion resistance does not apply to a motor enclosure, nor to bearings, laminations, or other minor parts of iron or steel, such as a washer, a screw, and the like, or to spot welds in coated materials used nonsubmerged and indoors.

Exception No. 3: A stainless steel cabinet or an enclosure may be used without additional corrosion resistance.

11.2 A sheet-steel cabinet or an electrical enclosure intended for outdoor use shall be protected against corrosion by the means specified in Table 11.1 or by other metallic or nonmetallic coatings that have been shown to provide equivalent resistance.

Exception: As specified in Exception Nos. 1 – 3 to 11.1.

Table 11.1
Paragraphs for judging protection against corrosion

Type of cabinet or enclosure	Minimum thickness of steel	
	0.056 inch (1.42 mm) and thicker	Less than 0.056 inch (1.42 mm) thick
Outer cabinet that protects a motor, wiring, or encloses current-carrying parts	11.3	11.4
Inside enclosure that protects current-carrying parts other than a motor	11.3	11.4
Outer cabinet that is the sole enclosure of current-carrying parts	11.4	11.4

11.3 With reference to Table 11.1, as applicable, one of the following coatings shall be used:

- a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G60 or A60 in Table I of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with no less than 40 percent of the zinc on any one side, based on the minimum single-spot test requirement in this

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designation. The weight of the coating shall be established in accordance with the test method of ASTM Designation A90-69, or by any method that has been determined to be similar. An A60 (alloyed) coating shall also comply with 11.6.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of no less than 0.00041 inch (0.0104 mm) on each surface, with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 44. An annealed coating shall also comply with 11.6.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint is to be determined by consideration of the composition or, when required, by the corrosion tests specified in 11.5.

d) A single coat of an organic finish of the epoxy or alkyd-resin type over phosphate- or oxide-treated steel in a form that has been shown to be equivalent to mill-galvanized steel as noted in (a). Organic coatings shall comply with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

11.3 revised January 14, 2011

11.4 With reference to Table 11.1, as applicable, one of the following coatings shall be used:

a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in Table I of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with no less than 40 percent of the zinc on any side, based on the minimum single-spot-test requirement in this designation. The weight of the zinc coating shall be established in accordance with the test method of ASTM Designation A90-69, or by any method that has been determined to be similar.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of no less than 0.00061 inch (0.01549 mm) on each surface with a minimum thickness of 0.00054 inch (0.01372 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 44. An annealed coating shall also comply with 11.6.

c) A cadmium coating no less than 0.001 inch (0.0254 mm) thick on both surfaces. The thickness of the coating shall be established in accordance with the Metallic Coating Thickness Test, Section 44.

d) A zinc coating that complies with 11.3 (a) or (b), with one coat of outdoor paint as specified in 11.3(c) on each surface.

e) A cadmium coating no less than 0.00075 inch (0.01905 mm) thick on both surfaces, with one coat of outdoor paint on both surfaces, or no less than 0.0005 inch (0.0127 mm) thick on both surfaces, with two coats of outdoor paint on each surface. The thickness of the cadmium coating shall be established in accordance with the Metallic Coating Thickness Test, Section 44, and the paint shall be as specified in 11.3(c).

11.5 With reference to Tables 11.1 and 11.2, other finishes, including paints, metallic finishes, and combinations of the two may be acceptable when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) that are in compliance with 11.3(a) or 11.4(a) indicate that they provide equivalent resistance. Among the factors considered when evaluating the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light, and water. Organic coatings shall comply with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

11.5 revised January 14, 2011

Table 11.2
Aluminum alloys

Sand-cast	Permanent-mold cast	Die-cast	Machined-bar and rod stock
319.0	319.0	360.0	5052
356.0	356.0	A360.0	5056
443.0	A356.0	413.0	5456
B443.0	443.0	A413.0	6061
514.0	B443.0	C443.0	6063
B514.0	B514.0	518.0	
520.0	535.0		
535.0			
A712.0			

11.6 A hot-dipped, mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing, and that is not otherwise required to be painted, shall be additionally painted in the bent or formed area when the bending or forming process damages the zinc coating. An area on the inside surface of a cabinet or enclosure that water does not enter during the rain test is not required to be painted.

11.7 When flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered to be damaged. Simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes shall comply with the requirement in 11.6.

11.8 A nonferrous cabinet and enclosure may be used without coatings for protection against corrosion. The use of dissimilar metals in contact with each other where corrosion could produce openings is not acceptable.

11.9 A hinge or other attachment on an outdoor or a submersible appliance shall be resistant to corrosion.

11.10 A metal part of a submersible pump that encloses or supports electrical parts and is normally in contact with water, including assembly rivets, bolts, screws, and the like, shall be of corrosion-resistant metal, such as stainless steel, copper, or aluminum alloy.

Exception: Cast-iron parts at least 1/8 inch (3.2 mm) thick, steel shafts coated with phosphate or black oxide, steel bolts coated with zinc dichromate, and other materials investigated and found to be acceptable.

11.11 Sheet and plate aluminum normally in contact with water shall be an alloy of the 5000 series as given in the Standard Specification for Aluminum Alloy Sheet and Plate, ASTM B-209 and cast aluminum shall be one of the alloys listed in Table 11.2, or shall be an alloy that has been found to have equivalent resistance to corrosion.

11.12 A part of a vessel supplied for use with a pump that is subjected to pressure, including a rivet, a screw, and a surface in contact with water, shall resist corrosion by means as described in 11.1 – 11.8.

12 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

12.1 To reduce the likelihood of unintentional contact that may involve a risk of:

- a) Electric shock from an uninsulated live part or film-coated wire or
- b) Injury to a person from a moving part, an opening in an enclosure shall comply with either (1) or (2):
 - 1) For an opening that has a minor dimension (see 12.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 12.1.
 - 2) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 12.1.

Exception: A motor other than one used in either a hand-held pump or a hand-supported portion of a pump is not required to comply with these requirements when it complies with the requirements in 12.2.

Table 12.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension ^a of opening,		Minimum distance from opening to part,	
inches	(mm) ^b	inches	(mm) ^b
3/4 ^c	19.1	4-1/2	114.0
1 ^c	25.4	6-1/4	165.0
1-1/4	31.8	7-1/2	190.0
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	444.0
d		30	762.0
^a See 12.5. ^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 only to a motor. ^d More than 2-1/8 inches, but not more than 6 inches (152 mm).			

12.2 With regard to a part or wire as mentioned in 12.1, in an integral enclosure of a motor as mentioned in the Exception to 12.1:

- a) An opening that has a minor dimension (see 12.5) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) A moving part or a film-coated wire cannot be contacted by the probe illustrated in Figure 12.2;

- 2) In an indirectly accessible motor (see 12.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 12.3; and
 - 3) In a directly accessible motor (see 12.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 12.4.
- b) An opening that has a minor dimension of 3/4 inch or more is acceptable if a part or wire is spaced from the opening as specified in Table 12.1.

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Figure 12.2
Probe for moving parts and film-coated wire

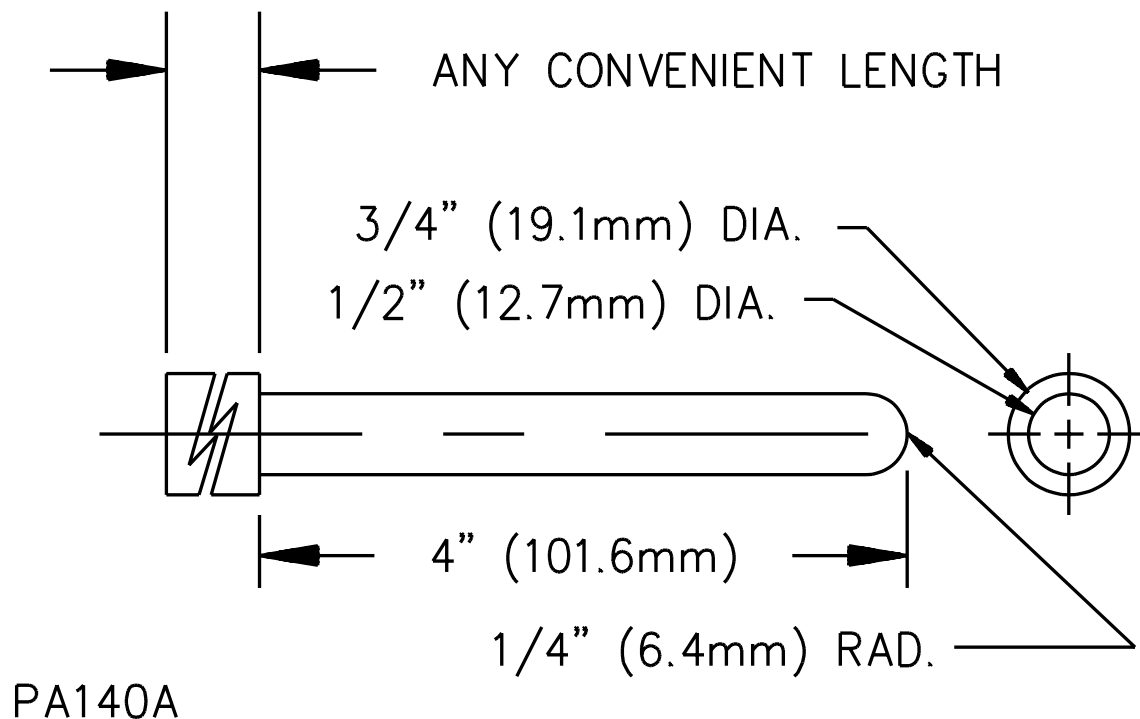
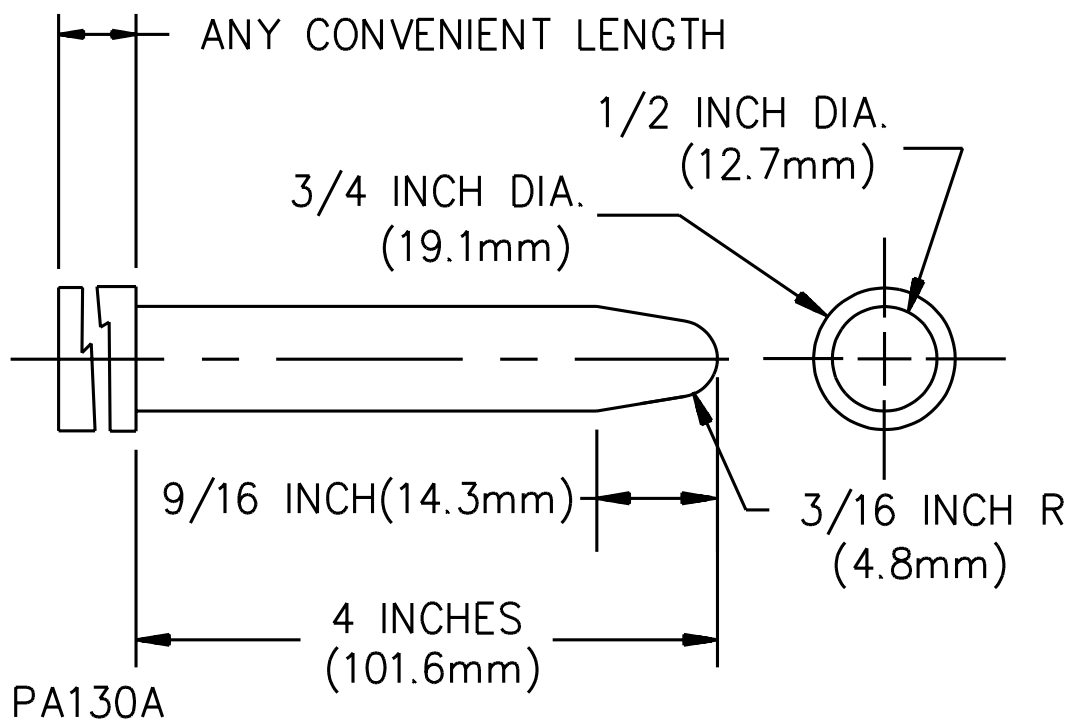


Figure 12.3
Probe for uninsulated live parts



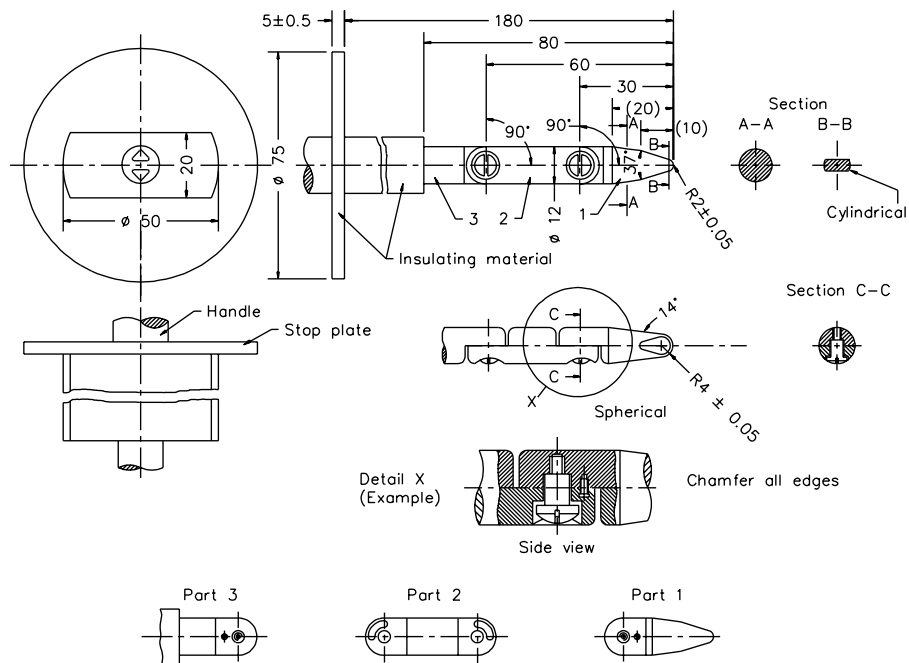
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Figure 12.4
International electrotechnical commission (IEC) articulate accessibility probe with stop plate



SA1788A

12.3 The probes specified in 12.1 and 12.2 and illustrated in Figures 12.1 – 12.4 shall be applied to any depth that the opening permits, and shall be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the enclosure. The probes illustrated in Figures 12.1 and 12.4 shall be applied in any possible configuration; and, when required, the configuration shall be changed after insertion through the opening.

12.4 The probes specified in 12.3 and 12.5 shall be used as measuring instruments to evaluate the accessibility provided by an opening, and not as instruments to evaluate the strength of a material; they shall be applied with the minimum force required to determine accessibility.

12.5 With reference to the requirements in 12.1 and 12.2, 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.

12.6 With reference to the requirements in 12.2, an indirectly accessible motor is a motor:

- a) That 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) That 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 can be contacted without opening or removing any part, or that is located so as to be accessible to contact.

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