



UL 1081

STANDARD FOR SAFETY

Swimming Pool Pumps, Filters, and Chlorinators

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UL Standard for Safety for Swimming Pool Pumps, Filters, and Chlorinators, UL 1081

Seventh Edition, Dated August 9, 2016

Summary of Topics

This revision of ANSI/UL 1081 is being issued to include requirements for button or coin cell batteries of lithium technologies.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 16, 2016.

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The most recent designation of ANSI/UL 1081 as an American National Standard (ANSI) occurred on October 21, 2016. 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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PART 1 – SWIMMING POOL PUMPS, FILTERS, AND CHLORINATORS

INTRODUCTION

1 Scope

1.1 These requirements apply to electric motor-operated water pumps of the nonsubmersible type, pump-filter combinations, and chlorinators for use with swimming pools, hot tubs, and spas, to be used in accordance with the National Electrical Code, NFPA 70. The pump is secured directly to the motor or the pump and motor are factory secured to a common frame.

1.2 These requirements also cover electric pool cleaners for use in swimming pools.

1.3 Swimming pool pumps, pump-filter combinations, and chlorinators covered by these requirements may be permanently connected or cord- and plug-connected to the electrical supply. Permanently-connected units may be covered for indoor use only or for indoor and outdoor use. Cord- and plug-connected units are evaluated under requirements for outdoor use, but may also be used indoors. Swimming pool pumps intended for use with storable pools are provided with a minimum 25-foot (7.6-m) nondetachable power supply cord, are double insulated, have no accessible grounded metal, and have inaccessible dead metal connected to the grounding conductor of the cord. Pumps intended for permanent use may be permanently wired or provided with a maximum 3-foot (0.91-m) nondetachable power supply cord and, in addition, are provided with an accessible wire connector for bonding to all metal parts of the pool, hot tub, or spa structure and to all electrical equipment conduit and piping within 5 feet (1.5 m) of the inside wall of the pool, hot tub, or spa. Hot tub and spa pumps covered by these requirements are not intended for use within an outer enclosure or beneath the skirt of a hot tub or spa, unless so marked.

1.4 Chlorinators covered by these requirements may consist of assemblies such as:

- a) A chlorinator and a clock-operated valve for use with a water circulating system;
- b) A water circulating pump with additional chlorine injection; or
- c) An electrolytic-type chlorinating equipment.

1.5 These requirements do not cover:

- a) Pumping equipment for fire service or other products that are covered by individual requirements elsewhere;
- b) A pump rated at more than 600 volts;
- c) A pump involving a universal motor rated at more than 250 volts: or
- d) A sump pump, fountain pump, and aquarium pump, or other products for which individual requirements exist.

2 Units of Measurement

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

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

3 Undated References

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

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 BASIC INSULATION (formerly FUNCTIONAL INSULATION) – The insulation applied to live parts to provide basic protection against electric shock. Basic insulation does not necessarily include insulation used exclusively for functional purposes.

4.3 CORD- AND PLUG-CONNECTED UNIT – A unit provided with flexible cord and an attachment plug for connection to the supply source.

4.4 DOUBLE INSULATION – An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and arranged so that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, or the like) to the same degree.

4.5 INDOOR UNIT – A unit investigated for use only where protected from the weather.

4.6 LINE VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit or limited-energy circuit.

4.7 OUTDOOR UNIT – A unit that has been investigated and determined to be acceptable for use where exposed to weather.

4.8 PERMANENTLY-CONNECTED UNIT – A unit that is intended for connection to one of the applicable permanent wiring systems in accordance with the National Electrical Code, ANSI/NFPA 70.

4.9 PERMANENTLY-INSTALLED POOL – A pool constructed wholly or partially in the ground, any pool capable of holding water in a depth greater than 42 inches (1.07 m), or any pool installed inside of a building (regardless of water depth), whether or not served by electrical circuits of any nature.

4.10 PERMANENTLY-INSTALLED UNIT – A unit intended to be fastened or secured in position or permanently connected to a water circulating system.

4.11 SAFETY CRITICAL FUNCTION – Control, protection and monitoring functions which are being relied upon to reduce the risk of fire, electric shock or casualty hazards.

4.12 STORABLE POOL – A pool constructed on or above the ground, capable of holding water to a maximum depth of 42 inches (1.07 m), and constructed so that it may be readily disassembled for storage and reassembled to its original integrity, or a pool with nonmetallic, molded polymeric walls or inflatable fabric walls, regardless of dimensions.

4.13 STORABLE POOL PUMP – A unit intended for use immediately adjacent to storable pools, and may or may not be incorporated in a filter combination.

4.14 SUPPLEMENTARY (PROTECTING) INSULATION – An independent insulation provided in addition to the basic insulation to reduce the risk of electric shock in case of mechanical rupture or dielectric breakdown of the basic insulation. An enclosure of insulating material may form a part or the whole of the supplementary insulation.

4.15 UNIT – A pump, a pump-filter combination, or a chlorinator.

5 Safety Critical Functions

5.1 Any function involved in the control, protection, and monitoring of safety-related attributes of a pump whereby a loss/malfunction of its functionality would represent an unacceptable risk of fire, electric shock, or casualty hazards would be considered a Safety Critical Function.

5.2 Electronic circuits that manage a Safety Critical Function shall be:

- a) Reliable as defined as being able to maintain the Safety Critical Function in the event of single defined component faults and
- b) Not susceptible to electromagnetic environmental stresses encountered in the anticipated environments of the appliance.

5.3 Electronic circuits managing Safety Critical Functions shall comply with:

- a) Supplement SA; or
- b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1 and its Part 2s as specified in this standard. The function shall be considered Class B. When utilizing UL 60730-1, surge protective devices are defeated for the EMC immunity testing unless they are provided with spark gaps (gas tube surge suppressors).

5.4 Functions specified in Table 5.1 represent the common safety critical circuit functions of pumps. It is not intended to represent all possible Safety Critical Functions.

Table 5.1
Safety Critical Functions

Function (see 5.1)	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	27.2
Motor locked rotor protection	Risk of fire or electric shock	27.2
Motor short circuit protection	Risk of fire or electric shock	27.2

CONSTRUCTION

6 Component Specifications

6.1 General

6.1.1 Except as indicated in 6.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

6.1.2 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,
- b) Is superseded by a requirement in this standard, or
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

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

6.1.4 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.

6.1.5 Components shall be suitable for the intended use and installation environment. This suitability shall assume the following installation parameters.

- a) Outdoor, Pollution Degree III installations
- b) Overvoltage Category II as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

6.1.6 Components not anticipated by the requirements of this Standard, not specifically covered by a component standard of Sections 6.2 – 6.5, 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.

6.2 Printed wiring boards

6.2.1 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 of UL 1081. Unless wholly in a Class 2 circuit, it shall comply with the direct support of live parts requirements in UL 796.

6.3 Quick-connect wire connectors

6.3.1 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.

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

6.4 Terminal blocks

6.4.1 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.

6.4.2 The UL 60947-7-x Standards are used in conjunction with the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1.

6.4.3 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.

6.5 Wire connectors

6.5.1 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.

6.5.2 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.

6.6 Button or coin cell batteries of lithium technologies

6.6.1 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more coin cell batteries of lithium technologies shall comply with the Standard for Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A, if the appliance or any accessory:

- a) Is intended for use with one or more single cell batteries having a diameter of 32 mm (1.25 in) maximum with a diameter greater than its height; and
- b) The appliance is intended for household use.

Exception: UL 4200A is not applicable to appliances and accessories intended for use where the battery is not intended to be replaced and is not referenced in instructions and markings.

7 Frame and Enclosure

7.1 An appliance shall be provided with an enclosure housing all electrical parts that present a risk of fire, electric shock, or injury to persons under all conditions of use.

7.2 The frame and enclosure of an appliance shall possess the strength and rigidity to resist the abuses to be encountered during service. The degree of resistance inherent in the unit shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects that alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

7.3 The enclosure of a unit for outdoor use, when of sheet metal, shall have a thickness of not less than 0.032 inch (0.81 mm) when uncoated or of not less than 0.034 inch (0.86 mm) when galvanized.

7.4 An enclosure of sheet metal, other than that covered in 7.3, is evaluated with regard to its size, shape, and thickness, considering the intended use of the complete unit. Sheet steel shall have a thickness of not less than 0.026 inch (0.66 mm) when uncoated, or 0.029 inch (0.74 mm) when galvanized. Nonferrous sheet metal shall have a thickness of not less than 0.036 inch (0.91 mm).

Exception: Relatively small areas or surfaces that are curved or otherwise reinforced are not prohibited from being thinner than specified.

7.5 An enclosure of cast metal shall not be less than 1/8 inch (3.2 mm) thick at every point, more than 1/8 inch thick at reinforcing ribs and door edges, and not less than 1/4 inch (6.4 mm) thick at tapped holes for conduit.

Exception: Other than at holes for conduit, die-cast metal shall not be less than:

- a) 3/32 inch (2.4 mm) thick for an area larger than 24 square inches (155 cm²) or having any dimension larger than 6 inches (152 mm) or*
- b) 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimension larger than 6 inches. This area limitation is capable of being obtained by the provision of reinforcing ribs subdividing a larger area.*

7.6 An enclosure of polymeric material shall be investigated with regard to operating temperatures, stress-relief distortion, impact resistance, resistance to abnormal conditions, and flame resistance, both in the original formed condition and after aging in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Such enclosures for outdoor equipment shall also be investigated with regard to resistance to ultraviolet light and water in accordance with the Resistance to Ultraviolet Light and Water Test, Section 41.

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7.7 The polymeric housing of a component is not considered to be an appliance enclosure unless this part is the sole insulation (excluding air) between a live part and an external surface of the appliance.

7.8 An enclosure shall be constructed to restrict water from reducing the effectiveness of the electrical insulation due to breakdown of water connections or shaft seals, flooding onto a mounting surface or within the enclosure, or breakdown of a boot, diaphragm, shaft seal, or similar part, as determined in 40.2.1 – 40.4.2.

7.9 An enclosure of an outdoor unit containing an electrical component, other than for a motor having a sealed housing, shall have provision for drainage if there is a knockout or unthreaded opening in the enclosure or if there is likelihood of the accumulation of condensation.

7.10 The enclosure of a storable pool pump shall be such that the lowest portion of any live part is at least 4 inches (101.6 mm) above the supporting surface. When a separate base is to be used in the field to provide the minimum 4-inch height, the portable unit shall be marked in accordance with 53.17 and provided with installation instructions as specified in 55.4.

Exception: Units complying with the requirements for submersible pumps as specified in the Standard for Motor-Operated Water Pumps, UL 778. Testing shall include, but not be limited to, 30-Day Submersion (under 4 inches of water).

7.11 A unit intended for permanent installation shall be provided with means for mounting or support. Fittings required for intended mounting, such as brackets, hangers, or the like, shall be furnished with the unit.

7.12 The enclosure shall restrict molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the unit is supported.

Exception: A permanently-installed unit not intended for mounting on a combustible surface is not prohibited from having an open bottom when it is marked in accordance with 53.6.

7.13 The requirement in 7.12 requires that a switch, transformer, relay, solenoid, or similar part be individually and completely enclosed other than at terminals unless it can be shown that malfunction of the component does not result in a risk of fire, or unless there are no openings in the bottom of the enclosure. There shall be no opening in the bottom of the enclosure located directly below field- or factory-made splices or overcurrent protective devices. The requirement in 7.12 also requires the use of a barrier of combustion-resistant material under:

a) A motor, unless:

- 1) The structural parts of the motor or of the overall unit provide the equivalent of such a barrier;
- 2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the unit when the motor is energized under each of the following four fault conditions, applied separately:
 - i) Main winding opened,
 - ii) Starting winding opened,
 - iii) Starting switch short-circuited, and

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iv) For a permanent-split-capacitor motor, the capacitor short-circuited (the short circuit is to be applied before the motor is energized and the rotor is locked); or

3) The motor is provided with a thermal motor protector (a protective device that is sensitive to both temperature and current) that limits the temperature of the motor windings to not more than 125°C (257°F) under the maximum load under which the motor runs without causing the protector to cycle, and from becoming more than 150°C (302°F) with the rotor of the motor locked.

b) Wiring, unless it is of the flame-retardant type. Neoprene- or PVC-, TFE-, PTFE-, FEP-insulated wires and wires bearing the surface marking "VW-1" are considered to be of this type.

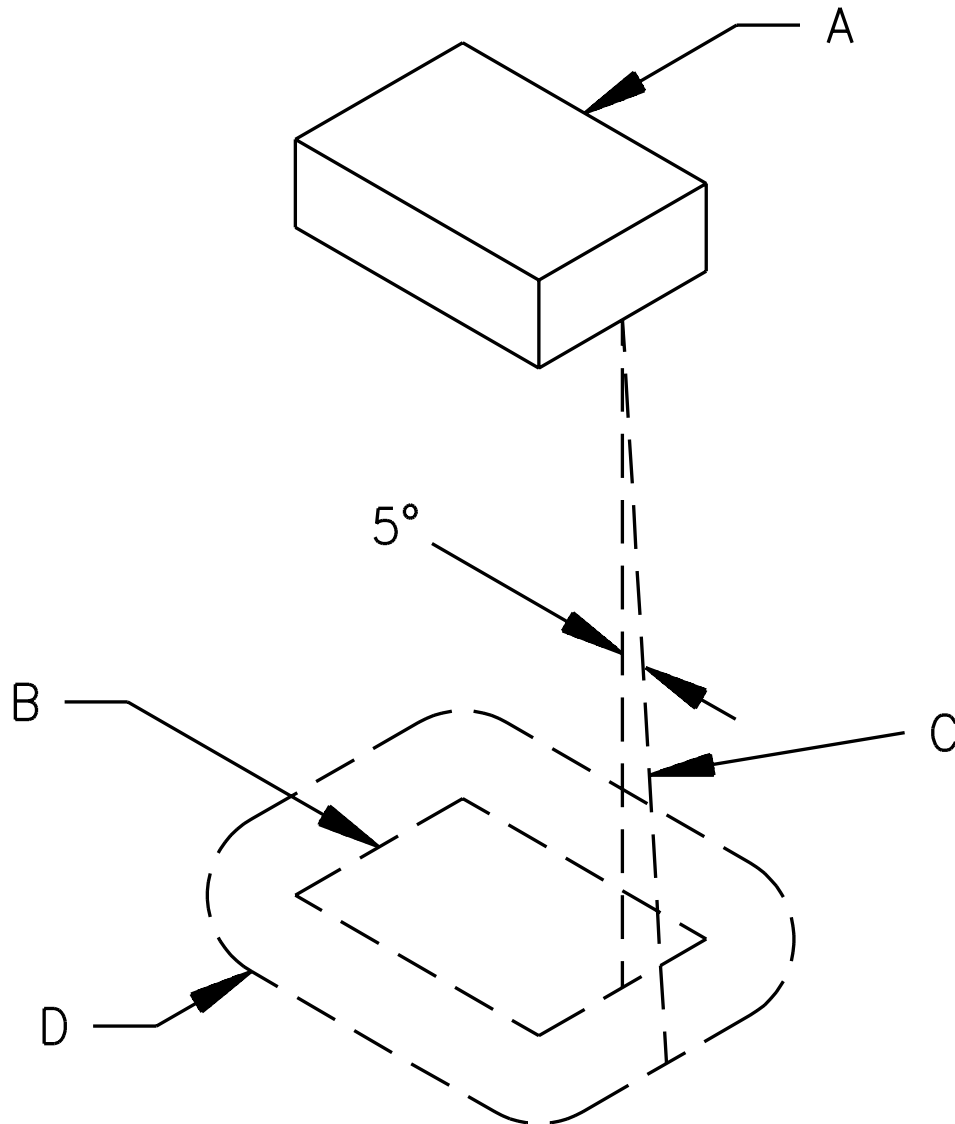
7.14 The barrier specified in 7.13 shall be horizontal, located as indicated in Figure 7.1, and possess an area not less than that described in the figure. Openings for drainage and ventilation are not prohibited from being used in the barrier, when such openings prevent molten metal, burning insulation, or the like from falling on combustible material.

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Figure 7.1
Location and extent of barrier



EB120A

- A – Region to be shielded by barrier. This consists of the entire component (unless otherwise shielded) and of the unshielded portion of a component that is partially shielded by the component enclosure or equivalent.
- B – Projection of outline of component on horizontal plane.
- C – Inclined line that traces out minimum area of barrier. When moving, the line is always tangent to the component, 5 degrees from the vertical, and 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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8 Mechanical Assembly

8.1 A unit shall be assembled so that it is not adversely affected by the vibration of intended operation. Brush caps shall be tightly threaded or otherwise constructed to reduce the risk of loosening.

8.2 A switch, a lampholder, an attachment plug receptacle, a motor attachment plug, or similar component shall be mounted securely and shall be restricted from turning.

Exception No. 1: A switch is not required to be restricted from turning when all four of the following conditions are met:

a) The switch is to be 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 intended operation of the switch);

b) Means of mounting the switch make it unlikely that operation of the switch loosens it;

c) The spacings are not reduced below the minimum required values when the switch rotates; and

d) Operation of the switch is to be by mechanical means rather than by contact by persons.

Exception No. 2: A lampholder of a type in which the lamp is incapable of being replaced (such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel) is not required to be restricted from turning when rotation does not reduce spacings below the minimum required values or adversely affect water resistance of outdoor units.

8.3 The means for restricting the turning specified in 8.2 is to consist of more than friction between surfaces – for example, a lock washer is to be used as means for restricting a small stem-mounted switch or other device having a single hole mounting means from turning.

8.4 An uninsulated live part shall be secured to the base or mounting surface so that it is restricted from turning or shifting in position when such motion results in a reduction of spacings below the minimum required values specified in Spacings, Section 22.

8.5 A part of polymeric material that is used to support a motor shall comply with the Creep Test, Section 48.

8.6 Tin-lead solder shall not be used for the fastening of seams or the assembly of parts.

8.7 Metal into which screws are threaded shall provide for the engagement of at least two full threads. Fastenings such as rivets, screws, bolts, or equivalent means in a sheet-metal enclosure shall have a diameter at least 50 percent greater than the thickness of the finished sheet metal with which they are used.

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

9.1 To reduce the risk of unintentional contact that involves a risk of electric shock from an uninsulated live part or film-coated wire, or injury to persons from a moving part, an opening in an enclosure shall comply with either (a) or (b):

- a) For an opening that has a minor dimension (see 9.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 9.1.
- b) 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 9.1.

Exception: A motor that complies with the requirements in 9.2 is not required to comply with these requirements.

Table 9.1
Minimum distance from an opening to a part that involves a risk of electric shock or injury to persons

Minor dimension of opening, ^a		Minimum distance from opening to part,	
inches ^b	(mm) ^b	inches	(mm)
3/4 ^c	(19.1)	4-1/2	(114)
1 ^c	(25.4)	6-1/2	(165)
1-1/4	(31.8)	7-1/2	(191)
1-1/2	(38.1)	12-1/2	(318)
1-7/8	(47.6)	15-1/2	(394)
2-1/8	(54.0)	17-1/2	(445)
d	d	30	(762)
^a See 9.5. ^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 to a motor only. ^d More than 2-1/8 inches, but not more than 6 inches (152 mm).			

9.2 With regard to a part or wire as specified in 9.1, in an integral enclosure of a motor as specified in the Exception to 9.1:

a) An opening that has a minor dimension (see 9.5) less than 3/4 inch (19.1 mm) complies with the requirements when:

- 1) A moving part is incapable of being contacted by the probe illustrated in Figure 9.2;
- 2) Film-coated wire is incapable of being contacted by the probe illustrated in Figure 9.3;
- 3) In a directly accessible motor (see 9.6), an uninsulated live part is incapable of being contacted by the probe illustrated in Figure 9.4; and
- 4) In an indirectly accessible motor (see 9.6), an uninsulated live part is incapable of being contacted by the probe illustrated in Figure 9.2.

b) An opening that has a minor dimension of 3/4 inch or more complies with this requirement when a part or wire is spaced from the opening as specified in Table 9.1.

Figure 9.2
Probe for moving parts and uninsulated live parts

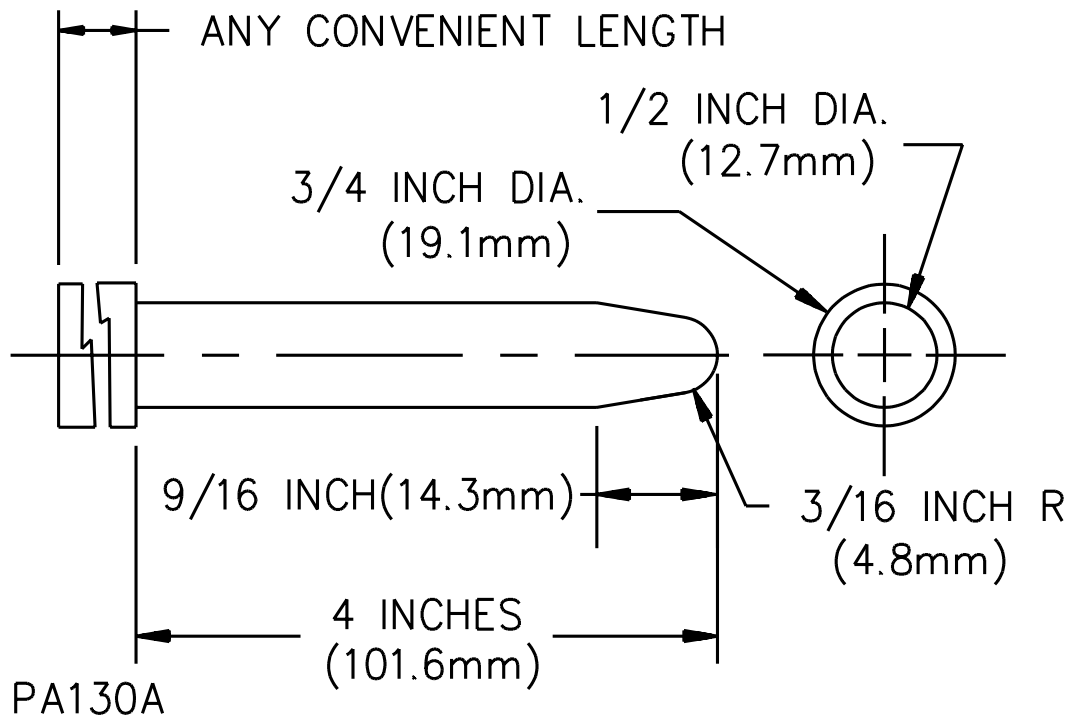
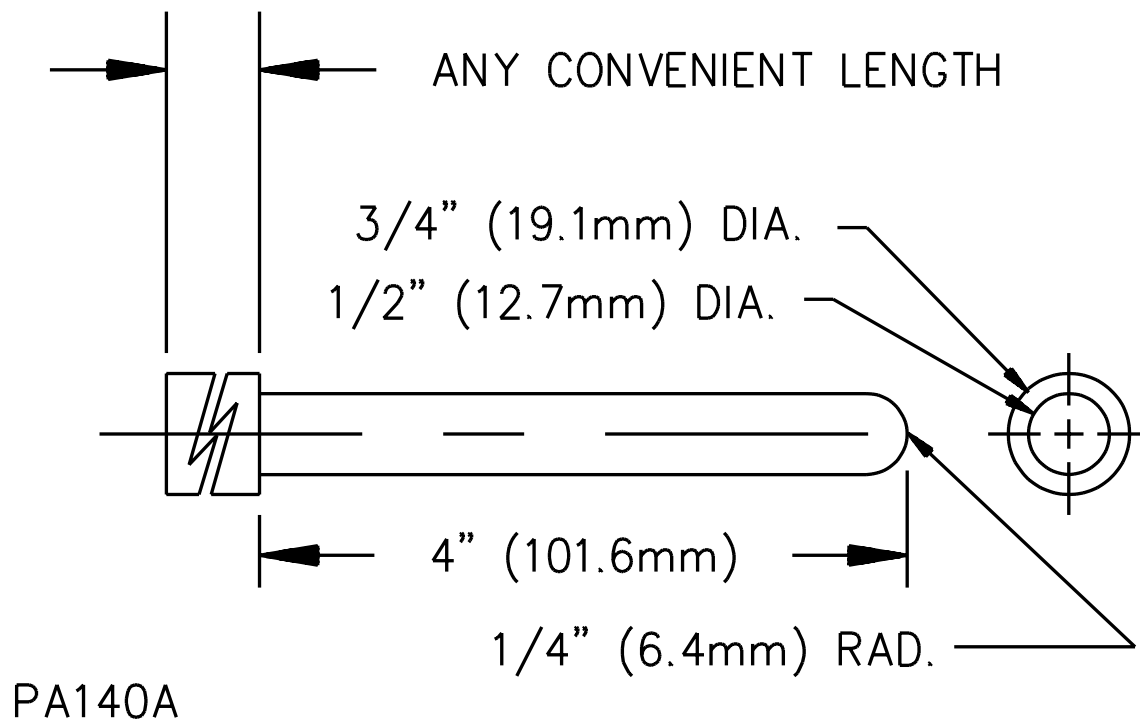


Figure 9.3
Probe for film-coated wire

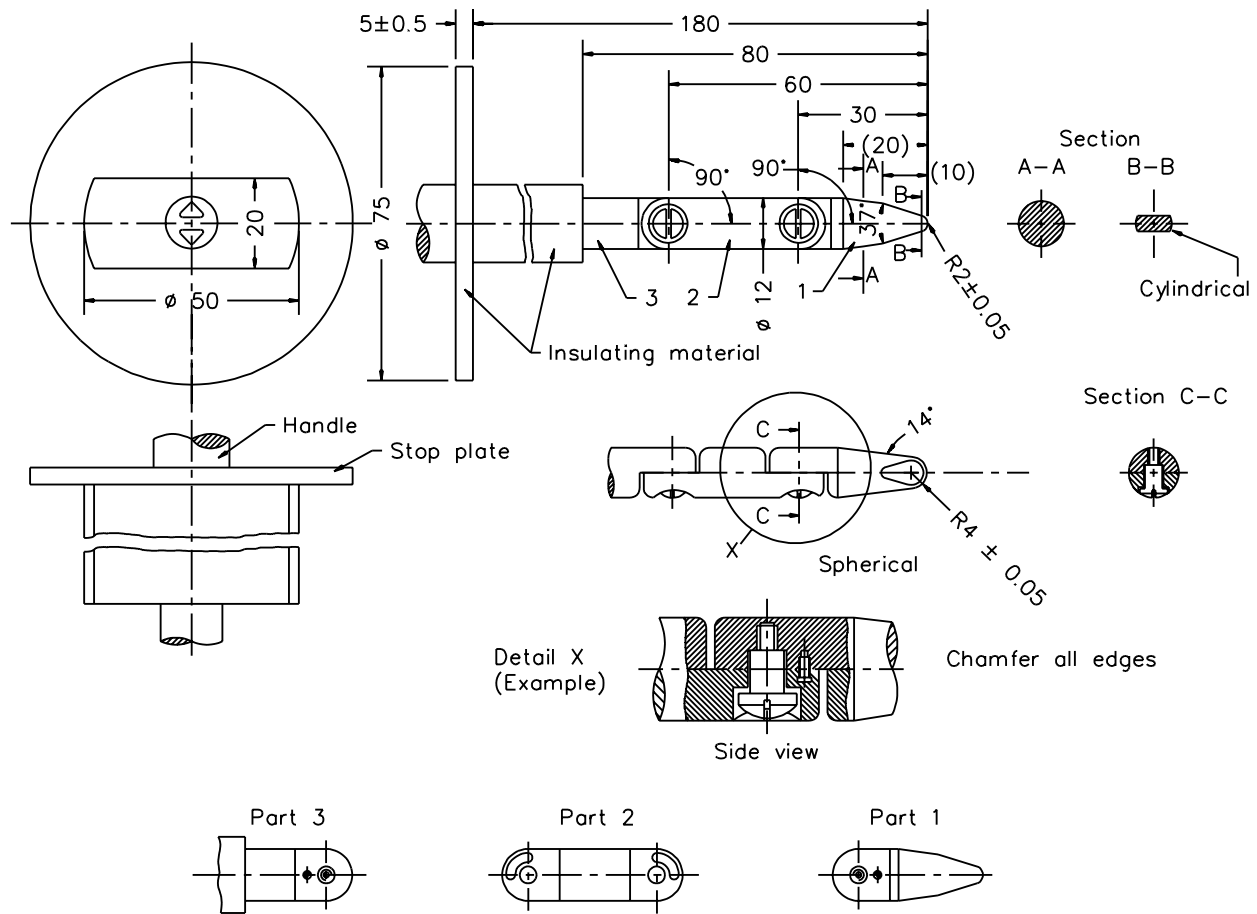


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Figure 9.4
IEC articulate probe



SA1788A

9.3 The probes specified in 9.1 and 9.2 and illustrated in Figures 9.1 – 9.4 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 probe illustrated in Figures 9.1 and 9.4 shall be applied in any possible configuration; and, when required, the configuration shall be changed after insertion through the opening.

9.4 The probes specified in 9.2 and 9.3 shall be used as measuring instruments to determine the accessibility provided by an opening, and not as instruments to determine the strength of a material; they shall be applied with the minimum force required to determine accessibility.

9.5 With reference to the requirements in 9.1 and 9.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that is capable of being inserted through the opening.

9.6 With reference to the requirements in 9.2, an indirectly accessible motor is a motor that is:

- a) Accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that is capable of being opened or removed without using a tool or
- b) Located at such a height or is otherwise guarded or enclosed so that it is not capable of being contacted.

A directly accessible motor is a motor that is capable of being contacted without opening or removing any part or that is located so as to be accessible to contact.

9.7 During the examination of a product to determine whether it complies with the requirements in 9.1 or 9.2, a part of the enclosure that is capable of being opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

9.8 With reference to the requirements in 9.1 and 9.2, insulated brush caps are not required to be additionally enclosed.

10 Provisions for Servicing

10.1 A protective device shall be wholly inaccessible from outside the unit without opening a door or cover; however, the operating handle of a circuit breaker, the operating button of a manually-operable motor protector, and similar parts may project outside the enclosure.

10.2 The door or cover of an enclosure shall be hinged when it provides access to any overload protective device, the functioning of which requires renewal or resetting (such as a manually-resettable, thermally-actuated switch), or when it is required to open the cover in connection with the intended operation of the protective device.

10.3 Any panel or cover in the enclosure of a unit for outdoor use shall require the use of a tool to open unless it can be determined that removal or opening of the panel for the rain, splash, and flooding tests does not result in a risk of electric shock.

10.4 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight fitting. Any fastener, door, or cover shall be captive to the unit.

11 Resistance to Corrosion

11.1 Iron and steel parts shall be made resistant to corrosion by enameling, galvanizing, plating, or other equivalent means when the corrosion of such unprotected parts results in a risk condition.

Exception No. 1: In certain instances where the oxidation of iron or steel due to the exposure of the metal to air and moisture is not appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast iron parts within an enclosure are not required to be corrosion resistant.

Exception No. 2: The requirement does not apply to bearings, laminations, or to minor parts of iron or steel, such as washers, screws, and the like.

11.2 Copper or copper alloy with zinc content not in excess of 15 percent is not prohibited from being used without special corrosion resistance.

11.3 Except as specified in 11.4, aluminum is acceptable without special corrosion resistance.

11.4 Sheet and plate aluminum that comes into contact with the pool water shall be of an alloy of the 5000 series as given in the Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, ASTM B209, and cast aluminum shall be one of the alloys specified in Table 11.1, or an alloy that has been investigated and determined to have equivalent resistance to corrosion.

11.5 Metal shall not be used in combinations to cause galvanic action that adversely affects cabinets or enclosures.

Table 11.1
Aluminum alloys

Sand-cast	Permanent-mold cast	Die-cast	Machined bar and rod stock
G4A	GM70B	G8A	5052
G10A	GS42A	S5C	5056
GM70B	S5A	S12A	5456
GS42A	S5B	S12B	6061
S5A	SG70A	SG100A	6063
S5B	SG70B	SG100B	
SG70A			
ZG61B			

11.6 A sheet steel enclosure and other parts, including hinges and other attachments, of an indoor or outdoor unit shall be protected against corrosion as described in 11.7 – 11.9.

11.7 An enclosure that contains any live part other than a motor shall be corrosion resistant as specified in 11.8(c), with or without the added epoxy or paint coating, or other protection called for in 11.8 and 11.9.

11.8 The outer sheet steel enclosure shall be made resistant to corrosion by one of the following:

- a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement. The weight of the zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M REV A.
- b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface, with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 47. An annealed coating shall also comply with 11.9.
- c) A coating that conforms with (1) or (2) and that has one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.
 - 1) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G60 or A60 in ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement. The weight of the zinc coating may be determined by any acceptable method; however, in case of question the weight of coating shall be established in accordance with the test method in ASTM A90/A90M REV A. An annealed coating shall also comply with 11.9.
 - 2) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 47. An annealed coating shall also comply with 11.9.
- d) A cadmium coating not less than 0.0010 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established by the Metallic Coating Thickness Test, Section 47.
- e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the Metallic Coating Thickness Test, Section 47, and the paint shall be as described in (c).
- f) Other finishes, including paints, special metallic finishes, and combinations of the two may be accepted when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with (a) indicate that these other finishes provide equivalent protection. Among the factors that are taken into consideration when evaluating such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide 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.

11.9 An annealed coating on sheet steel that is bent or similarly formed or extruded, or rolled at edges of holes after annealing, shall be additionally painted in the affected areas if the process damages the zinc coating. If 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 damaged. Simple sheared or cut edges and punched holes are not required to be additionally protected.

12 Power Supply Connections – Cord- and Plug-Connected Units

12.1 Cords and plugs

12.1.1 Units intended for use with storable swimming pools shall be cord- and plug-connected.

12.1.2 A cord- and plug-connected unit shall be provided with a permanently attached flexible cord of a water-resistant type, Type SEW, SEOW, SJW, SJOW, SJEW, SJEOW, SJTW, SJTOW, SOW, STW, or STOW. Both the cord and the attachment plug shall not be rated less than the rated voltage of the unit. The ampacity of the cord shall not be less than the current rating of the unit, and the current rating of the attachment plug shall not be less than 125 percent of the current rating of the unit.

12.1.3 The flexible cord specified in 12.1.2 shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Standard for Flexible Cords and Cables, UL 62. Attachment plugs shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

12.1.4 The cord length for a storable pool pump shall be a minimum of 25 feet (7.62 m). The cord length for permanently-installed units shall be a maximum of 3 feet (0.91 m). The length is measured from the point at which the cord emerges from the unit to the face of the attachment plug.

12.1.5 A permanently-connected unit that is provided with a maximum 3-foot (0.91 m) long cord shall have a grounding-type attachment plug of the locking type with a fixed grounding contact.

Exception: The grounding-type attachment plug of a unit intended for permanent connection that is provided with a maximum 3-foot cord is not required to be of the locking type when the unit is marked for installation at least 10 feet from the inside walls of the pool in accordance with 53.20.

12.1.6 The grounding conductor shall not be smaller than the circuit conductors in the cord.

12.1.7 The grounding conductor of a permanently-connected unit with a maximum 3-foot (0.91-m) long cord shall be minimum 12 AWG (3.3 mm²) copper.

12.1.8 Inside the enclosure of a double-insulated and grounded unit, the power supply cord shall not contact a dead metal part that is accessible to the user without the use of a tool.

12.1.9 Inside the enclosure of a double-insulated and grounded unit, the power supply cord is not prohibited from being insulated from an accessible dead-metal part by insulation in the form of:

- a) An insulating liner,
- b) A coating of insulating material, or
- c) A sleeve around the cord, when the sleeve is loose-fitting and is secured at one end to the enclosure.

12.2 Strain relief

12.2.1 Strain relief shall be provided to restrict a mechanical stress on a flexible cord from being transmitted to terminals, splices, or interior wiring, as determined in the Strain Relief Test, Section 45. The strain relief shall be independent of any required water seals and shall restrict flexing or movement of any such seals.

12.2.2 Unless the clamp is insulated from the cord, a metal strain relief clamp of a double-insulated and grounded unit shall not be accessible and shall not make contact with an accessible dead-metal part.

12.2.3 Means shall be provided to restrict the flexible cord from being pushed into the unit through the cord entry hole when such displacement subjects the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated, or reduces spacings (such as to a metal strain relief clamp) below the minimum required values.

12.2.4 A knot in the supply cord shall not be used to provide strain relief.

12.3 Bushings

12.3.1 A bushing of insulating material shall be provided at each point at which the flexible cord passes through the metal of the enclosure. A bushing of rubber, neoprene, polyvinyl chloride, or similar material is not to be used for this application.

13 Power Supply Connections – Units Intended for Permanent Installation

13.1 General

13.1.1 A unit intended for permanent installation shall also be a permanently-connected unit.

Exception: A permanently-installed unit is not prohibited from being provided with a maximum 3-foot (0.91-m) long power supply cord and plug as specified in Power Supply Connections – Cord- and Plug-Connected Units, Section 12.

13.1.2 A permanently-connected unit shall be provided with a terminal compartment for the connection of power supply conductors.

Exception: A terminal compartment provided as an integral part of a motor that complies with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and is marked "Acceptable for Field Wiring" or the equivalent, is considered to comply with the requirements for a terminal compartment specified in 13.1.3 – 13.2.12.

13.1.3 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 steel as measured when uncoated, not less than 0.034 inch (0.86 mm) thick steel when galvanized, or not less than 0.045 inch (1.14 mm) thick when nonferrous.

13.1.4 There shall be a flat surface surrounding a knockout or conduit opening. The flat surface shall have an area that permits assembly of a length of standard rigid metallic conduit to the appliance. The diameter of the opening shall accommodate conduit of the trade size for which the opening is intended and either the flat surface and opening shall have a minimum diameter, or the throat shall have a diameter, in accordance with Table 13.1.