UL 1081

STANDARD FOR SAFETY

Swimming Pool Pumps, Filters, and Chlorinators

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 dated July 23, 2020 includes the following:

Addition of reference to UL 61800-5-1 as a replacement to UL 508C; 27.2.3.3, 29.11

Addition of reference to UL 62368-1 as an alternative to UL 60950-1; 68.5

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.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated April 10, 2020.

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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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CONTENTS

PART 1 – SWIMMING POOL PUMPS, FILTERS, AND CHLORINATORS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

MANUFACTURING AND PRODUCTION-LINE TESTS

RATINGS

MARKINGS

INSTRUCTIONS

PART 2 – ELECTRIC SWIMMING POOL CLEANERS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

RATINGS

MARKINGS

INSTRUCTIONS

SUPPLEMENT SA – REQUIREMENTS FOR THE EVALUATION OF ELECTRONIC CIRCUITS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

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

Relocated to Clause 25.3.

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 cm^2) 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.

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

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

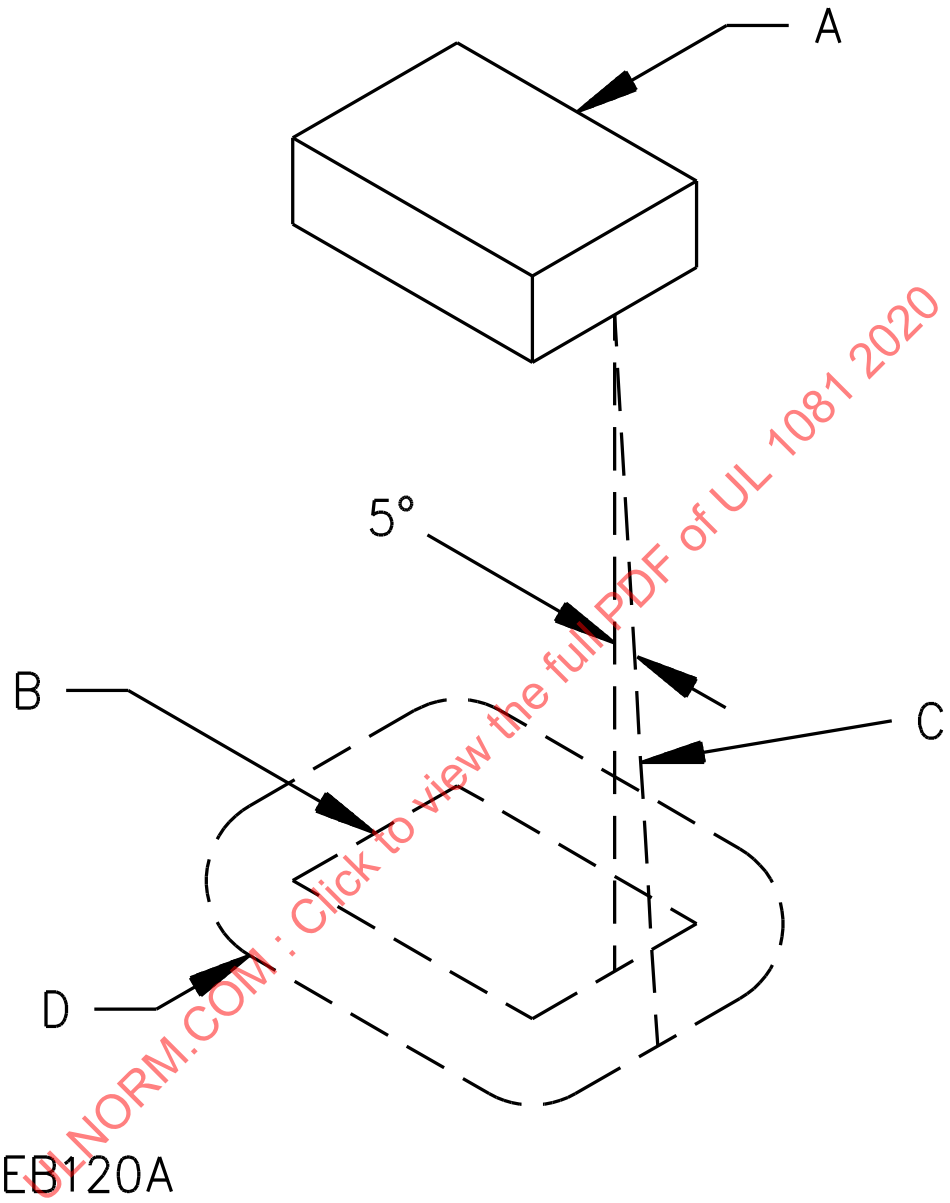
3) The motor is provided with a thermal motor protector (a protective device that is sensitive to both temperature and current) that limits the temperature of the motor windings to not more than 125°C (257°F) under the maximum load under which the motor runs without causing the protector to cycle, and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

Figure 7.1

Location and extent of barrier



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.

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.

Figure 9.1

Articulate probe with web stop

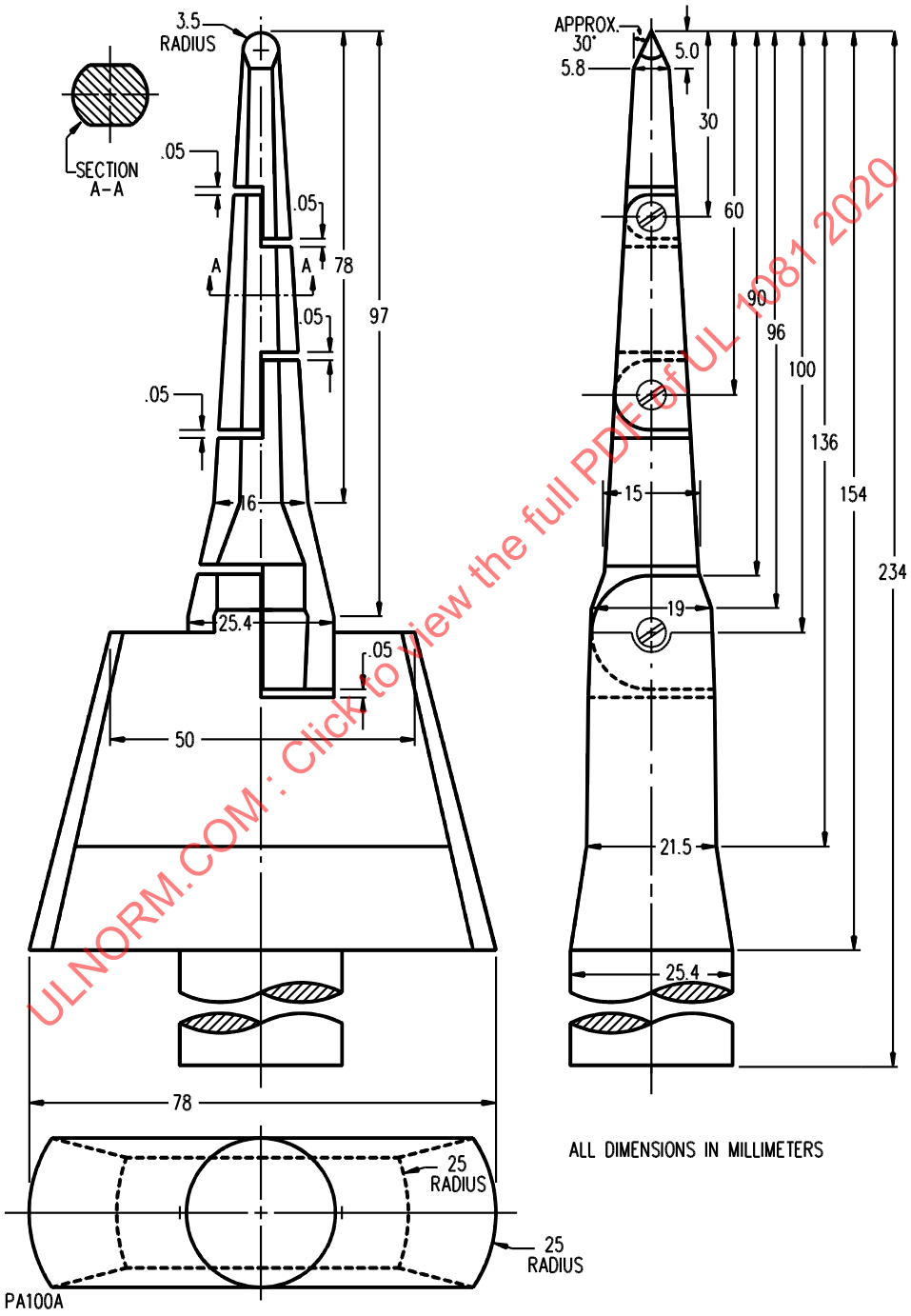


Table 9.1
Minimum distance from an opening to a part that involves a risk of electric shock or injury to persons

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

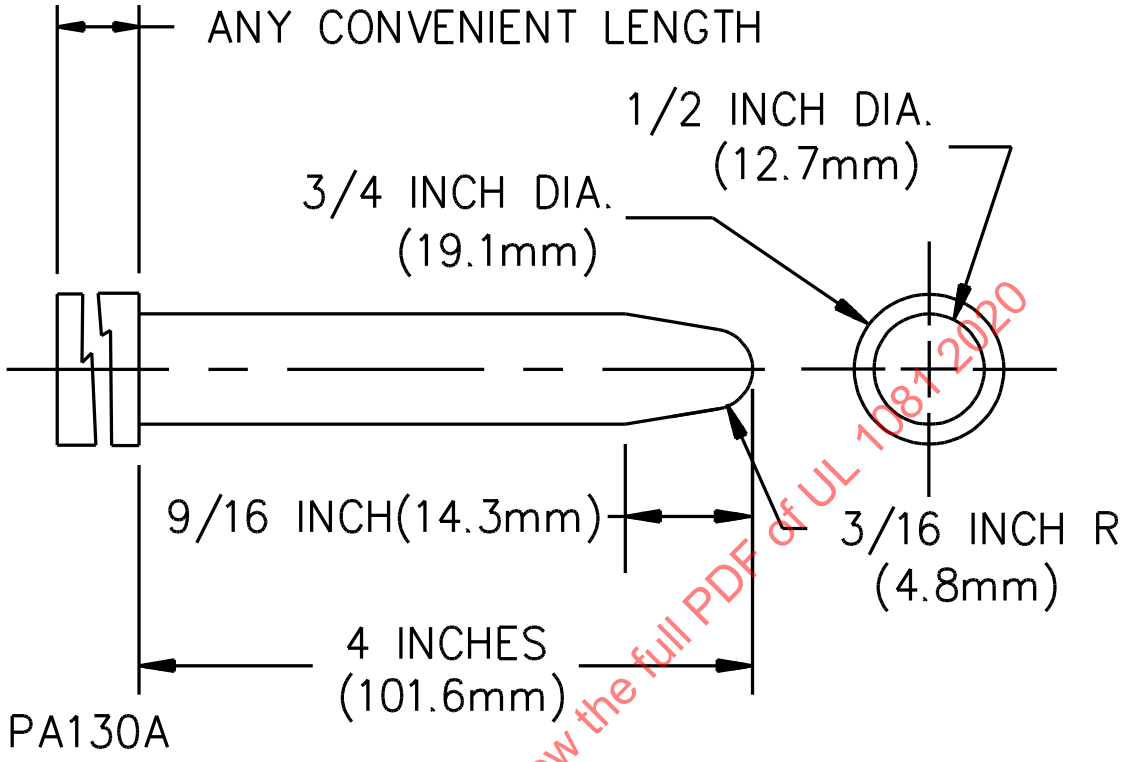


Figure 9.3

Probe for film-coated wire

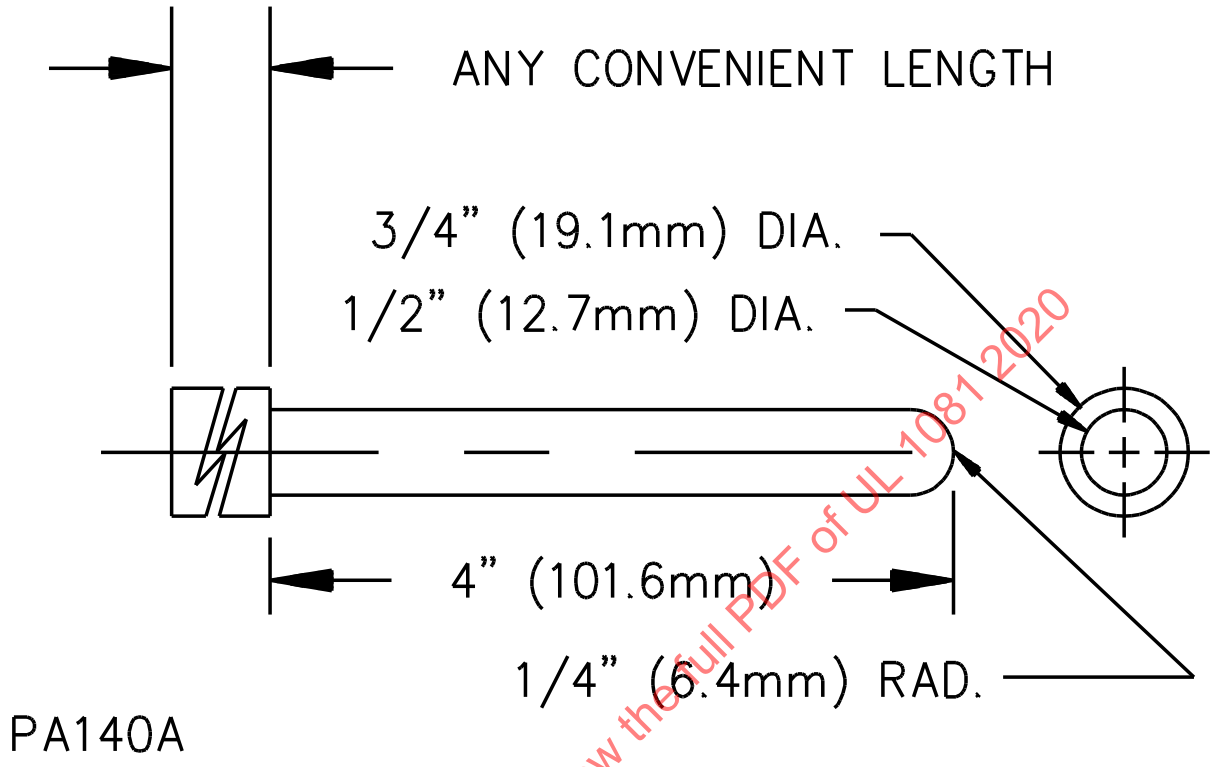
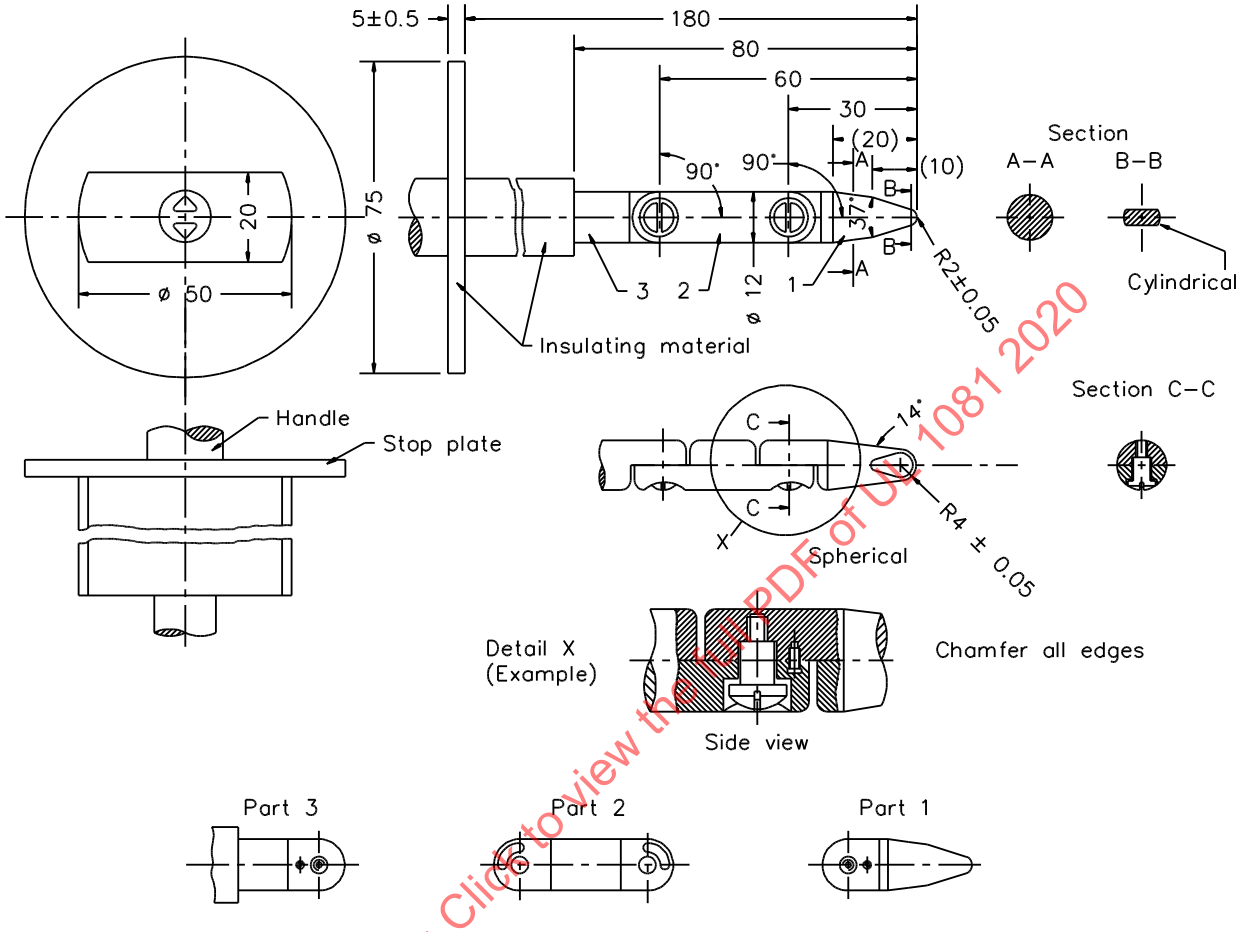


Figure 9.4

IEC articulate probe



9.3 The probes specified in 9.1 and 9.2 and illustrated in Figure 9.1 – Figure 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 Figure 9.1 and Figure 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 with a fixed grounding contact.

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 mm^2) 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.

Table 13.1
Dimensions associated with openings for conduit

Trade size of conduit, inches	Unthreaded openings				Threaded openings			
	Nominal knockout diameter		Minimum diameter of flat surface at knockout		Minimum throat diameter		Maximum throat diameter	
	Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
1/2	7/8	(22.2)	1.140	(28.96)	0.560	(14.22)	0.622	(15.80)
3/4	1-3/32	(27.8)	1.420	(36.07)	0.742	(18.85)	0.824	(20.93)
1	1-23/64	(34.5)	1.770	(44.96)	0.944	(23.98)	1.049	(26.64)
1-1/4	1-23/32	(43.7)	2.281	(57.94)	1.242	(31.55)	1.380	(35.05)

13.1.5 A permanently-connected unit intended for installation outdoors shall:

a) Have an integral conduit hub or the equivalent for a watertight connection, or

b) Be shipped with a separate hub intended to be installed in the field that complies with 13.1.11.

Exception No. 1: When the conduit connection opening is wholly below the lowest terminal lug or other live part intended for use within the enclosure, a threaded conduit hub or the equivalent is not required.

Exception No. 2: Provision for a conduit hub or fitting is not required to be provided when information is provided in accordance with 53.27.

13.1.6 If a hole provided for the connection of conduit is threaded the threads are tapped all the way through a hole in an enclosure wall, or when an equivalent construction is used, there shall be neither less than 3-1/2 nor more than five threads in the metal, and the construction shall be such that a conduit bushing can be attached. When the threads are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall not be fewer than five full threads in the metal, and there shall be a smooth, well-rounded inlet hole for the conductors that shall:

a) Afford protection to the conductors equivalent to that provided by a standard conduit bushing and

b) Have an internal diameter the same as that of the corresponding trade size of rigid conduit.

13.1.7 The threads of a conduit entry shall comply with Pipe Threads, General Purpose (Inch), ASME B1.20.1; Threaded Conduit Entries, CSA C22.2 NO. 0.5, or Unified Screw Threads – Specifications, ANCE NMX-H-146-SCFI.

13.1.8 A conduit hub in an enclosure shall be threaded and shall have a wall thickness before threading not less than that of the corresponding trade size of conduit. A conduit hub that is not cast integrally with an enclosure shall not depend upon friction alone to restrict its turning, and shall be capable of withstanding the specified torque applied to a short length of rigid conduit threaded into the hub in the intended manner, without turning in the enclosure and without stripping of any threads. The enclosure shall be rigidly mounted or supported. For the 3/4-inch and smaller trade sizes, the applied torque shall be 800 pound-inches (90.4 N·m); for the 1-, 1-1/4-, and 1-1/2-inch trade sizes, the applied torque shall be 1000 pound-inches (113 N·m); and for the 2-inch and larger trade sizes, the applied torque shall be 1600 pound-inches (181 N·m).

Exception: Units terminating a single conduit of 3/4 maximum trade size need only be subjected to a tightening torque of 200 pound-inches (22 N·m).

13.1.9 A polymeric enclosure intended for connection to a rigid metallic conduit system shall comply with the Polymeric Enclosures – Rigid Metallic Conduit Connection Test specified in the Standard for Enclosures for Electrical Equipment, Non-Environmental Consideration, UL 50.

Exception No. 1: Units marked in accordance with 53.25 are only required to be subjected to the Torque Test of UL 50.

Exception No. 2: Units intended for a field installed hub and marked in accordance with 53.26 are not required to be subjected to the Torque Test of UL 50.

13.1.10 A knockout or hole for connection of a field wiring system to a field wiring compartment shall accommodate conduit of the trade size shown in Table 13.4.

Table 13.2
Trade size of conduit in inches

Wire size,		Number of wires		
AWG	(mm^2)	2	3	5
14	(2.1)	1/2	1/2	1/2
12	(3.3)	1/2	1/2	1/2
10	(5.3)	1/2	1/2	1/2
8	(8.4)	3/4	3/4	3/4

Table 13.2 Continued on Next Page

Table 13.2 Continued

Wire size,		Number of wires		
AWG	(mm^2)	2	3	5
6	(13.3)	3/4	1	1

NOTE – This table is based on the assumption that all conductors will be of the same size and there will be not more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

13.1.11 A conduit hub shipped with a pump in accordance with 13.1.5 (b) shall be suitable for wet locations and comply with the requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

13.2 Terminal compartments for supply connection

13.2.1 A terminal compartment intended for connection of a supply raceway shall be attached to the unit so as to be restricted from turning with regard to the unit.

13.2.2 A terminal compartment in which connections to the power supply circuit are made shall be located so that, after the unit has been installed as intended, such connections are accessible for inspection.

13.2.3 A terminal compartment shall be complete and shall enclose all field wiring terminals and all splices to be made in the field unless the enclosure is otherwise complete – that is, unless all sides and a complete bottom are provided when the unit is shipped from the factory. No ventilation opening shall be located in the terminal compartment.

Exception: A ventilated terminal compartment is capable of being used in a ventilated motor frame having ventilation openings when there is no opening directly beneath any live part in the compartment.

13.2.4 The compartment specified in 13.2.2 shall be located so that when conduit connections are being made, internal wiring and electrical components shall not be exposed to mechanical abuse or strain.

13.2.5 Wiring space or other compartments in a swimming pool appliance intended to be wired in the field and that enclose wiring shall be free of any sharp edge, burr, fin, moving part, or similar obstruction that is capable of damaging the conductor insulation.

13.2.6 A wiring compartment intended for housing wire-to-wire field connections shall have minimum dimensions and usable volumes in accordance with Table 13.3.

Table 13.3
Minimum volume of field wiring compartments

Size of conductor,		Free space in compartment for each conductor	
AWG	(mm^2)	cubic inches	(cm^3)
14	(2.1)	2.0	(33.0)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.4)	3.0	(49.2)
6	(13.3)	5.0	(82.0)

13.2.7 A terminal compartment that encloses rigidly-mounted wiring terminals for field-connection to a power supply circuit shall provide room for spacings in accordance with Table 22.2, usable volume not less than that specified in Table 13.4, and bending space not less than that specified in Table 13.5.

Table 13.4
Terminal compartments for rigidly-mounted terminals

Power supply conductor size,		Minimum usable volume per power supply conductor,	
AWG[a]	(mm^2)	cubic inches	(cm^3)[b]
14	(2.1 and smaller)	1	(16)
12 and 10	(3.3 and 5.3)	1-1/4	(20)
8 and 6	(8.4 and 13.3)	2-1/4	(370

[a] Based on copper supply conductors having a temperature rating of 60°C (140°F), except that connection of aluminum supply conductors is assumed when terminals are rated for use with aluminum conductors.

[b] The specified volume is not applicable to motors with higher ratings, greater number of leads, or larger wire sizes, or for motors intended to be installed as a part of factory-wired equipment, without additional connection being required at the motor terminal housing during equipment installation, and the terminal housing shall be of ample size to make connections.

13.2.8 In lieu of the volume specified in Table 13.3, a trial installation may be made to determine that ample room is provided for the distribution of wires and cables required for the proper wiring of the equipment. However, wire-bending space shall be provided in accordance with 13.2.10.

13.2.9 To determine whether the equipment complies with 13.2.8, it is to be wired as it would be in service, and in so doing, a reasonable amount of slack is to be left in each conductor. No more than average care is to be exercised in stowing this slack into the wiring compartment. The wiring shall not bear against sharp projections or edges that may damage the insulation.

13.2.10 The depth of the compartment in the vicinity of any opening at which supply conductors may enter shall be such that the required space for wire bending and manipulation will remain between any wire connector, wiring lug, conduit knockout, or conduit hole and any wall of the wiring compartment that would result in the wire bending, as specified in Table 13.5.

Table 13.5
Wire bending space

Wire size		Minimum space, terminal to wall	
AWG	(mm^2)	Inches	(mm) [a]
14 – 10	(2.1 – 5.3)	Not specified	
8 – 6	(8.4 – 13.3)	1-1/2	(38.1)

[a] If a conductor is restricted from bending by a barrier or otherwise where it leaves the lug, the distance is to be measured from the end of the barrier.

13.2.11 The terminal compartment shall have provision for drainage.

13.2.12 When a door is provided necessary to maintain the environmental integrity, it shall have provisions for locking or require the use of a tool to gain access.

13.3 Wiring terminals and leads

13.3.1 A permanently-connected unit shall be provided with leads or terminals for the connection of supply conductors. They shall be sized for the connection of conductors having an ampacity of not less than:

a) The rating of the branch circuit fuse shown in the marking on the unit when it is marked in accordance with 53.12 or

b) 125 percent of the current rating of the motor plus the sum of the other loads.

13.3.2 A sheet-metal screw shall not be used as a wiring terminal or for securing a wiring terminal such as a pressure-wire connector.

13.3.3 A field-wiring terminal shall be rated for use with:

a) Copper conductors only,

b) Aluminum conductors only, or

c) Copper or aluminum conductors,

and shall be marked as indicated in 53.15.

13.3.4 A wiring terminal shall be provided with a soldering lug or with a pressure-wire connector, firmly bolted or held by a screw.

Exception: A wire-binding screw is to be used at a terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor when upturned lugs or the equivalent are used to hold the wire in position.

13.3.5 When a wire-binding screw or a pressure-wire connector is used as a terminating device for aluminum wire, it shall also be capable for use with aluminum under the conditions involved (for example, temperature, heating, and cycling).

13.3.6 A wire-binding screw shall thread into metal.

13.3.7 A wire-binding screw at a wiring terminal shall not be smaller than No. 10 (4.8 mm diameter).

Exception: A No. 8 (4.22 mm) screw is not prohibited from being used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm) screw is not prohibited from being used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm^2) conductor in a control circuit.

13.3.8 A 14 AWG (2.1 mm^2) is the smallest conductor that is capable of being used for branch circuit wiring, and thus is the smallest conductor that shall be anticipated at a terminal for connection of a power supply wire.

13.3.9 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick. There shall not be fewer than two full threads in the metal, which is not prohibited from being extruded when required to provide the threads.

13.3.10 A unit intended for connection to a grounded power supply conductor and using a lampholder of the Edison screw shell type, or a single pole switch or control, shall have one terminal or lead identified for the connection of the grounded conductor supply circuit. The identified terminal or lead shall be the one connected to screw shells of lampholders and shall not be the one connected to a single pole switch or control.

13.3.11 A terminal for connection of a grounded power supply conductor shall be of, or plated with, metal that is substantially white in color and shall be readily distinguishable from the other terminals; or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

13.3.12 A lead intended for the connection of a grounded power supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from the other leads.

13.3.13 The requirements in 13.3.11 and 13.3.16 relating to color coding for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

13.3.14 The free length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more when the lead is intended for field connection to an external circuit.

Exception: The lead is not prohibited from being less than 6 inches when the field wiring supply connections are enclosed in the motor terminal box or motor wiring compartment.

13.3.15 A lead intended to be spliced in the field to a power supply conductor shall not be smaller than 18 AWG (0.82 mm^2).

13.3.16 The surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

14 Grounding

14.1 All units

14.1.1 All units shall be provided with means for connection to the branch circuit equipment grounding conductor.

14.2 Permanently-connected units

14.2.1 Each permanently-connected unit shall be provided with a lead or terminal within the terminal compartment specified in 13.2.1 solely for connection of an equipment grounding conductor. A sheet-metal screw shall not be used for this purpose. When the unit has provision for wiring through the supply connection point to other equipment, two such terminals shall be provided. The terminal or terminals shall be:

a) Located so that they are incapable of being removed during servicing of the unit;

b) Capable of securing a copper conductor rated for the application but not smaller than 12 AWG (3.3 mm^2); and

c) Either:

1) A wire-binding screw having a green-colored head that is hexagonal shaped, slotted, or both or

2) A pressure-wire connector plainly identified by being marked "G," "GR," "Ground," or "Grounding."

14.2.2 A lead provided for connection to an equipment grounding conductor shall comply with 13.3.14 and 13.3.16.

14.3 Cord- and plug-connected units

14.3.1 The grounding blade of the attachment plug and the noncurrent-carrying metal parts required to be bonded to the equipment grounding conductor shall be electrically conductively connected.

14.3.2 A grounding adaptor shall not be provided.

14.3.3 The resistance between the point of connection of the equipment grounding means (grounding terminal or termination of grounding conductor of cord within the unit) and any other point in the grounding circuit within the unit shall not be more than 0.1 ohm.

14.3.4 The equipment grounding conductor of the supply cord shall be secured by a screw or similar means that is incapable of being removed during any servicing operation that does not involve the power supply cord.

14.3.5 A sheet-metal screw shall not be used for this purpose.

14.3.6 Solder alone shall not be used for this purpose.

14.4 Bonding

14.4.1 General

14.4.1.1 Except as noted for double-insulated and grounded units, the metal enclosure of each unit and all accessible metal that could become energized in the event of a fault shall be bonded to the equipment grounding as specified in 14.1.1 – 14.3.6. Bonding shall be by conductive metal-to-metal mounting or by bonding conductors. The metal-to-metal connection shall be made by bolting, brazing, or welding. Metal screws may be used for a metal-to-metal bonding connection if retained by at least two full threads. All bonding connections shall penetrate paint and other nonconductive coatings.

14.4.2 Double insulated plus grounded units

14.4.2.1 The grounding conductor of a double-insulated unit shall be connected to inaccessible metal only. All inaccessible noncurrent-carrying metal that encloses electrical parts or that could become energized in the event of a fault shall be bonded to the grounding conductor.

14.4.2.2 A noncurrent-carrying metal part that serves to enclose any live part such as the enclosure of a motor, or is capable of becoming energized, shall be grounded and inaccessible to contact by the user.

14.5 Equipotential bonding

14.5.1 A bonding wire connector of copper or copper alloy shall be provided on a unit intended for permanent connection. The wire connector shall be on the exterior surface or at a point easily accessible for field connection, and shall be able to accommodate a 8 AWG (8.4 mm^2) copper conductor.

Exception: Double-insulated and grounded units shall not be provided with a wire connector for equipotential bonding purposes.

14.5.2 The wire connector required in 14.5.1 is for the purpose of bonding all noncurrent-carrying metal parts of the unit to the equipotential bonding grid of the swimming pool.

15 Ground-Fault Protection for Personnel

15.1 Pumps for storable swimming pools shall be provided with a factory installed ground-fault circuit-interrupter (GFCI).

15.2 The GFCI shall comply with the requirements for a Class A ground-fault circuit-interrupter as specified in the Standard for Ground-Fault Circuit-Interrupters, UL 943, and be either:

a) An integral part of the attachment plug; or

b) Located such that it is in the supply cord within 12 inches (305 mm) of the attachment plug.

15.3 The GFCI shall be rated for outdoor use.

16 Live Parts

16.1 A current-carrying part shall be of silver, copper, a copper alloy, or equivalent material.

16.2 Plated iron or steel is not prohibited from being used for a current-carrying part whose temperature during intended operation is greater than 100°C (212°F); within a motor or associated governor; or when in accordance with 6.1.1; however, plain (unplated) iron or steel is not to be used. The foregoing restrictions do not apply to stainless steel and any other corrosion-resistant alloys.

17 Internal Wiring

17.1 The internal wiring and connections between parts shall be guarded or enclosed.

17.2 The protection of insulated wiring and of wire providing grounding continuity, as required in 17.1, is considered to exist when the wiring, evaluated as though it were film-coated wire, complies with 9.1 and 9.2. For wiring other than in cord- and plug-connected units, compliance with this requirement is achieved when the wiring is secured within the enclosure so that it is incapable of being subjected to stress or mechanical abuse.

17.3 Insulated internal wiring (including a grounding conductor) shall consist of wire of a type or types that have been investigated with regard to:

a) The temperature and voltage to which the wiring is subjected;

b) Exposure to oil, grease, cleaning fluid, or other substances capable of damaging the insulation;

c) Exposure to moisture; and

d) Other conditions of service to which it is subjected.

17.4 Internal wiring shall be standard building wire or appliance wiring material with thermoplastic or thermosetting (neoprene, rubber, or cross-linked polyethylene) insulation.

17.5 Internal wiring shall comply with the Standard for Fixture Wire, UL 66; the Standard for Thermoset-Insulated Wires and Cables, UL 44; the Standard for Thermoplastic Insulated Wires and Cables, UL 83; or the Standard for Appliance Wiring Material, UL 758.

17.6 When the wiring of a unit is located so that it is in close proximity to combustible material, or is capable of being subjected to mechanical damage, it shall be in armored cable, conduit, electrical metallic tubing, metal raceway, or similarly protected.

17.7 Wires within an enclosure, compartment, raceway, or the like shall be located or protected to prevent contact with any sharp edge, burr, fin, or moving part that is capable of damaging the conductor insulation.

17.8 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire are restricted from contacting other live parts not always of the same polarity as the wire and from contacting dead-metal parts. This is capable of being accomplished by use of pressure-terminal connectors, soldering lugs or crimped eyelets, by soldering all strands of the wire together, or by other similar means.

18 Double Insulation

18.1 Units intended for use with storable swimming pools shall be double insulated and grounded.

18.2 A unit that is double insulated and grounded, whether it is required to be or not, shall comply with the requirements in 18.3 – 18.14.

18.3 A double-insulated unit shall be constructed so that when a wire, wire-connecting strap, screw, washer, spring, or similar part breaks, loosens, or otherwise becomes free to move, spacings involving protecting insulation are not reduced to less than the minimum required values, or to such an extent that results in a live part becoming accessible.

18.4 Compliance with the requirement in 18.3 is accomplished by use of barriers, relative placement of parts, physical restraint of the conductor (in addition to that resulting from its electrical connections), or by other means.

18.5 The requirement in 18.2 requires that a brush-holder be constructed so that, upon removal of the cap, the spring does not touch accessible metal.

18.6 Internal wiring that is exposed to handling during user-servicing (such as replacement of lamps) shall be secured at each end of the exposed length so that it is not dislodged from its intended position to such extent as to expose basic insulation or uninsulated live parts or to result in disruption of the electric circuit.

18.7 A length of double-insulated wiring that is protected by only a decorative housing of a type removed during investigation of the insulating features of the unit is considered to be exposed to handling during user-servicing.

18.8 Internal wiring, including an insulated splice, shall not make contact with an accessible dead-metal part.

18.9 A connection of a lead to a switch and a connection of a lead to a conductor of the power supply cord shall be made so that when the switch or power supply cord is to be replaced, it is not required to:

a) Sever a conductor;

b) Disconnect a soldered and taped splice between two conductors; or

c) Disconnect a soldered joint between a lead and a bus bar or strap.

18.10 A supplementary part (such as an insulating barrier or liner) necessary to maintain the level of insulation shall be secured to the unit so that it remains in place when the power supply cord or the switch is being replaced.

18.11 In a double-insulated unit, the insulation between a grounded part and a surface accessible to the user shall be a material intended for the insulation of live parts.

18.12 The control of a double-insulated unit shall be a manually-operated switch when:

a) The switch enclosure is of insulating material;

b) All live parts of the switch, other than terminals, are contained within the switch enclosure;

c) No noncurrent-carrying metal part that extends outside the switch enclosure enters the arc chamber;

d) The actuator that contacts live parts is wholly of insulating material;

e) With the exposed external parts of the actuator removed, no live part inside the switch enclosure is accessible;

f) Other than as noted in 18.13, metal-mounting screws or rivets by which the switch is secured to accessible noncurrent-carrying metal of the unit do not pass through the enclosure of the switch (but may pass through projections of the switch enclosure or through a piece of insulating material secured to the switch); and

g) A portion of a switch that contains arcing parts is separated from exposed noncurrent-carrying metal by mica not less than 0.005 inch (0.13 mm) thick, or by other equivalent insulation, and metal switch assembly screws, rivets, clamps, or other devices that pass through or around the enclosure of the switch are insulated from the noncurrent-carrying metal to which the switch is secured.

18.13 A switch that does not comply with 18.12(f) shall be used for the control of a double-insulated unit when the switch is inaccessible, mounted so that all its noncurrent-carrying metal parts are grounded, and operated by means of a linkage of insulating material.

18.14 On a double-insulated unit, a noncurrent-carrying metal part that:

a) Serves to enclose any live part such as the enclosure of a motor; or

b) Could become energized,

shall be insulated or spaced away from accessible noncurrent-carrying metal of the unit and from the water being pumped.

19 Splices

19.1 A splice and connection shall be mechanically secure and shall provide the required electrical contact.

19.2 A soldered connection shall be made mechanically secure before being soldered.

19.3 On a unit in which significant vibration is capable of occurring, the requirements in 19.1 and 19.2 require the use of lock washers or similar means to restrain wire-binding screws and nuts from loosening.

19.4 A splice shall be provided with insulation equivalent to that of the wires involved when permanence of spacing between the splice and other metal parts is not provided.

19.5 Insulation consisting of thermoplastic-insulating tape layered to 1/32 inch (0.8 mm) minimum thickness, or of one layer of friction tape on top of one layer of rubber tape, is not prohibited from being used on a splice when the voltage involved is less than 250 volts. In determining when splice insulation

consisting of coated fabric, thermoplastic, or other type of tubing is capable of being used, consideration is to be given to such factors as its dielectric properties, heat- and moisture-resistant characteristics, and the like. Thermoplastic tape wrapped over a sharp edge is not to be used.

20 Separation of Circuits

20.1 Unless provided with insulation rated for the highest voltage involved, conductors of line-voltage and low-voltage circuits (internal wiring, including wires in a terminal box or compartment) shall be separated by barriers or shall be segregated, and shall, in any case, be so separated or segregated from uninsulated live parts connected to different circuits.

20.2 Segregation of insulated conductors shall be accomplished by clamping, routing, or similar means that provides permanent separation from insulated or uninsulated live parts of a different circuit.

20.3 A field-installed conductor of any circuit shall be segregated by a barrier from:

a) A field-installed conductor connected to any other circuit,

b) A factory-installed conductor connected to another circuit unless the field-connected circuit has the highest voltage rating and the factory-installed conductor is insulated for the maximum voltage of the field-connected circuit, and

c) An uninsulated live part of any other circuit.

20.4 With regard to 20.3(a), a removable barrier or one having openings for the passage of conductors are to be used, when instructions for the use of the barrier are a permanent part of the unit. When complete instructions (in conjunction with a wiring diagram) provide for the separation of the line-voltage and low-voltage circuits, the barrier is, upon investigation, not required.

20.5 Separate provisions for field connection to circuits of line voltage and low voltage shall be provided.

20.6 A barrier used to provide separation between the wiring of different circuits shall be of metal or of evaluated insulating material; of the required physical strength when exposed or subject to mechanical damage; and securely held in place. Unclosed openings in a barrier for the passage of conductors shall not be larger in diameter than 1/4 inch (6.4 mm), and shall not exceed in number, on the basis of one opening per conductor, the number of wires that need to pass through the barrier. The closure for any other opening shall present a smooth surface wherever an insulated wire is in contact with it, and the area of any such opening, with the closure removed, shall not be larger than required for the passage of the wires.

20.7 A metal barrier shall have a thickness at least as great as the required thickness of the enclosure metal. A barrier of insulating material shall not be less than 0.028 inch (0.71 mm) thick and shall be of greater thickness when its deformation is capable of being readily accomplished so as to defeat its purpose.

21 Insulating Material

21.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or similar material.

21.2 Moisture absorptive material shall not be used for electrical insulation where shrinkage, current leakage, water absorption, or warpage introduces a risk of electric shock.

21.3 Thermoplastic material is not to be used for the sole support of an uninsulated live part; it is not prohibited from being used when determined to have mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric withstand, and other properties similar to those of the materials specified in 21.1.

21.4 A small molded part, such as a brush cap, shall be constructed to have the mechanical strength and rigidity to withstand the stresses of service.

22 Spacings

22.1 Double-insulated units

22.1.1 The spacings in a double-insulated unit shall comply with Table 22.1.

Table 22.1
Spacings through air or over surface in double-insulated units

Between	Minimum spacings							
	A live part, including film-coated wire wound in the form of a coil and held in place,		Accessible metal part,		Accessible surface of an enclosure of insulating material[a],		Outer surface of wrapped coil,	
	inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
Inner surfaces of insulating material that serves as protecting insulation	1/32	(0.8)	–		–		1/32	(0.8)
Inaccessible, grounded noncurrent-carrying metal	1/16	(1.6)	1/16	(1.6)	1/16	(1.6)	–	
Coil of open core and coil construction	–		1/8	(3.2)	–		–	
A live part, including film-coated wire wound in the form of a coil and held in place	–		1/8	(3.2)	1/8	(3.2)	–	

[a] When the outer surface of the enclosure consists wholly or partially of insulating material, the term accessible noncurrent-carrying metal part includes a foil wrap around the outside of the enclosure.

22.2 All other units

22.2.1 The spacings within a motor shall comply with the spacings requirements specified in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

22.2.2 The spacing between wiring terminals of opposite polarity, and the spacing between a wiring terminal and any other uninsulated metal part not of the same polarity, shall not be less than that indicated in Table 22.2.

Table 22.2
Spacings at wiring terminals

Potential involved, volts	Between wiring terminals through air or over surface,		Minimum spacings between terminals and other uninsulated metal parts not always of the same polarity[a]			
			Over surface,		Through air,	
	inch	(mm)	inch	(mm)	inch	(mm)
250 or less	1/4	(6.4)	1/4	(6.4)	1/4	(6.4)
More than 250	1/2	(12.7[b])	1/2	(12.7[b])	3/8	(9.5)

[a] Applies to the sum of spacings involved where an isolated noncurrent-carrying part is interposed.

[b] A spacing of not less than 3/8 inch (9.5 mm), through air and over surface, is not prohibited at wiring terminals in a wiring compartment or terminal box when the compartment or box is integral with a motor.

22.2.3 Other than at wiring terminals and as noted in 22.2.6, the spacing between uninsulated live parts of opposite polarity and between uninsulated live parts and a noncurrent-carrying metal part that is exposed to contact by persons or that is grounded shall not be less than the value indicated in Table 22.3. When an uninsulated live part is not rigidly fixed in position (by means other than friction between surfaces), or when a moveable noncurrent-carrying metal part is in proximity to an uninsulated live part, the construction shall be such that the required minimum spacing is maintained.

22.2.4 Spacing requirements specified in 22.2.1 – 22.2.3 do not apply to the internal spacings of a component of the unit. The acceptability of a component shall be determined in accordance with 6.1.1.

22.2.5 At terminal screws and studs to which connection is made in the field by means of wire connectors, eyelets, or the like, the spacings shall not be less than those shown in Table 22.3 when such connectors, eyelets, or the like are positioned so that minimum spacings (opposite polarity and to noncurrent-carrying metal) exist.

Table 22.3
Minimum spacings at other than field-wiring terminals

Potential involved, volts	Over surface,		Through air,	
	inch	(mm)	inch	(mm)
0 – 125	3/32	(2.4)	3/32	(2.4)
126 – 250	3/32	(2.4)	3/32	(2.4)
251 – 600	1/2	(12.7[a])	3/8	(9.5[a])

[a] Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch (2.4 mm) over surface and through air between film-coated wire, rigidly supported and held in place on a coil, and a dead-metal part is not prohibited.

22.2.6 When an isolated noncurrent-carrying metal part is interposed between or is in close proximity to:

a) Live parts of opposite polarity;

b) A live part and an exposed noncurrent-carrying metal part; or

c) A live part and a noncurrent-carrying metal part that is grounded,

the spacing shall not be less than 3/64 inch (1.2 mm) between the isolated noncurrent-carrying metal part and any one of the other parts previously specified, when the total spacing between the isolated noncurrent-carrying metal part and the two other parts is not less than the value indicated in Table 22.3.

22.2.7 An insulating lining or barrier of vulcanized fiber or similar materials used where minimum spacings are not capable of being used shall not be less than 1/32 inch (0.8 mm) thick, and shall be located or of such material so that it is not adversely affected by arcing.

Exception No. 1: Vulcanized fiber not less than 1/64 inch (0.4 mm) thick shall be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 2: Insulating material having a thickness less than that specified shall be used, when upon investigation, it is determined to provide protection against arcing.

22.2.8 Moisture-absorptive material shall not be used for an insulating lining or barrier in a unit for outdoor use or in other units where the material is capable of being exposed to moisture in use.

22.3 Clearance and creepage distances

22.3.1 As an alternative approach to the spacing requirements specified in Spacings, Section 22, and other than as noted in 22.3.2 and 22.3.3, clearances and creepage distances may be evaluated in accordance with the requirements in the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840, as described in 22.3.4.

22.3.2 Clearances between an uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable, shall be as noted in Table 22.3. The clearances shall be determined by physical measurement.

22.3.3 The clearance and creepage distance at field wiring terminals shall be in accordance with the requirements in Table 22.2.

22.3.4 In conducting evaluations in accordance with the requirements in the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840, the following guidelines shall be used:

a) The installation environment shall be considered Pollution Degree 3.

b) For evaluating clearances:

1) Pumps intended to be permanently wired to their supply shall be evaluated for Overvoltage Category II;

2) The Phase-to-Ground Rated System Voltage used in the determination of clearances shall be the equipment rated supply voltage rounded to the next higher value.

3) To determine equivalence with current through air spacings requirements an impulse test potential having a value as determined in UL 840 is to be applied.

c) For evaluation of creepages:

1) Any printed wiring board which complies with the requirements for Direct Support in the Standard for Printed-Wiring Boards, UL 796, provides a Comparative Tracking Index (CTI) of 100;

2) Printed wiring boards are evaluated as Pollution Degree 2 when adjacent conductive material is covered by any coating, such as a solder mask, which provides an uninterrupted covering over at least one side and the complete distance up to the other side of conductive material;

3) Printed-wiring boards shall be evaluated as Pollution Degree 1 under one of the following conditions:

i) A coating which complies with the requirements for Conformal Coatings in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, or

ii) At a specific printed wiring board location by application of at least a 1/32 inch (0.79 mm) thick layer of silicone rubber or through potting, without air bubbles, in epoxy or potting material.

23 Internal Bushings

23.1 When a conductor passes through an opening in a sheet metal wall that is 0.042 inch (1.07 mm) or less thick, it shall be held away from the edges of the opening, or shall be protected by a bushing, a grommet, or by rolling the edge of the metal at the opening not less than 120 degrees. A bushing, when used, shall be securely held in place, and shall not be less than 1/16 inch (1.6 mm) thick [with a minus tolerance of 1/64 inch (0.4 mm) for manufacturing variations]. The edges of an opening in sheet metal thicker than 0.042 inch shall be treated to reduce the possibility of abrasion of the insulation by the removal of burrs, fins, and sharp edges.

23.2 A fiber bushing is not to be used in a unit through which water is circulated.

24 Gaskets

24.1 A gasket used to seal an enclosure or pump housing shall comply with the requirements after conditioning, for tensile strength and elongation specified in the tests for property profile information table in the Standard for Gaskets and Seals, UL 157. Gaskets and seals shall not be required to comply with the minimum property values specified in UL 157 prior to conditioning.

Exception: The unit complies with the requirements in this standard in the absence of the gasket or seals.

25 Reduction of Risk of Injury to Persons

25.1 General

25.1.1 When an automatic-reset type of protective device is used in a unit, the automatic restarting of the motor shall not result in any risk of injury to persons.

25.1.2 The requirement in 25.1.1 requires the use of an interlock in the pump when moving parts or the like are capable of being damaged upon automatic restarting of the motor.

25.1.3 An edge, projection, or corner of an enclosure, opening, frame, guard, handle, or the like shall be smooth and well-rounded, and shall not cause a laceration or cut-type injury during intended use or during user maintenance.

25.1.4 A moving part, such as a rotor of a motor, a pulley, a belt, and a gear, shall be enclosed or guarded to reduce the risk of injury to persons.

25.1.5 With reference to the requirement in 25.1.4, the degree of resistance required of the enclosure depends upon the general construction and intended use of the unit. The factors to be taken into evaluation in determining the acceptability of an exposed moving part are:

a) The degree of exposure;

b) The sharpness of the moving part;

c) The speed of movement of a part; and

d) The risk of unintentional contact with the moving part, such as fingers, arms, or clothing being drawn into the moving part (at points where gears mesh, where a belt travels onto a pulley, or where moving parts close in a pinching or shearing action).

25.2 Stability

25.2.1 A cord-connected unit shall be provided with a base of such dimensions that it remains in its intended operating position on a plane inclined in any direction at 20 degrees to the horizontal, with and without water in filters or other reservoirs, and with hoses or tubes connected.

25.3 Button or coin cell batteries of lithium technologies

25.3.1 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 No. 1: UL 4200A is not applicable in appliances and accessories that meet the following:

a) The battery is not intended to be replaced.

b) The battery is not referenced in the instructions or markings.

c) A battery access door or cover is not provided.

d) The appliance or accessory is not intended to be handheld during normal operation.

Exception No. 2: UL 4200A is not applicable if the enclosure or other means of making the battery inaccessible complies with the requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

26 Parts Subject to Water Pressure

26.1 A part that is subject to pressure developed by a pump during operation shall be subjected to the Hydrostatic Pressure Test, Section 44.

Exception No. 1: The test is not required to be performed when it is obvious that the strength of the part is apparent as a result of its material and dimensions – for example, copper or steel pipe of standard sizes and provided with standard fittings are determined to have the required strength.

Exception No. 2: A pressure vessel bearing the inspection symbol, other than the UM symbol, of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers is not required to be subjected to the test when the vessel is marked with a value of working pressure not less than that to which it is subjected during operation.

26.2 A part that is subjected to pump pressure is determined to be a vessel used on a unit as a permanent part of a water-circulation system, and that contains a valve or resistance to water flow so as to build up the pressure to the developed pressure of the pump. Vessels such as water-filter enclosures on cord- and plug-connected units with direct, unvalved outlets to the pool are not determined to be subjected to the water pressure developed by the pump.

27 Motors

27.1 General

27.1.1 A motor shall be capable of handling the maximum intended load of the unit as described in 36.2 without increasing the risk of fire or electric shock.

27.1.2 A motor winding shall be such as to resist the absorption of moisture and shall be formed and assembled in a uniform manner, such as free of loose turns, irregular crossovers, and poor ties.

27.1.3 With reference to the requirement in 27.1.2, film-coated wire is not required to be additionally treated for moisture resistance; however, fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated for such purpose.

27.1.4 A brush-holder assembly shall be constructed so that when a brush is worn out (incapable of performing its intended function) the brush, spring, and other parts of the assembly shall be retained to the degree required to restrain an accessible dead-metal part from becoming energized, and a live part from becoming accessible.

27.1.5 An electric motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, except as noted below:

a) The Current and Horsepower Relation, Cord-Connected Motors, Factory Wiring Terminals and Leads and Non-Metallic Functional Parts sections of UL 1004-1 are not applicable.

b) A solid-state control that complies with the Standard for Solid-State Controls for Appliances, UL 244A, is considered to fulfill the Motors Provided With Controls requirements of UL 1004-1. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills the requirements in UL 244A.

c) See 7.6 of UL 1081 for the applicability of the Frame and Enclosure (nonmetallic) requirements of UL 1004-1.

d) Metal enclosure requirements of UL 1004-1 are superseded by the requirements of Section 7, Frame and Enclosure, of UL 1081.

e) Grounding requirements of UL 1004-1 are superseded by the requirements of Section 14, Grounding, of UL 1081.

f) The Ventilation Opening requirements of UL 1004-1 are only applicable where the openings are on surfaces considered to be the appliance enclosure (see 7.7 of UL 1081).

g) The Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts requirements of UL 1004-1 is superseded by Section 9, Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, of UL 1081.

h) The Protection Against Corrosion requirements of UL 1004-1 are superseded by Section 11, Resistance to Corrosion, of UL 1081.

i) The available fault current ratings for motor start and running capacitors specified in UL 1004-1 are not applicable to cord and plug connected pumps.

j) The Switches section of UL 1004-1 is not applicable to centrifugal starting switches.

k) With the exception of the Resilient Mounting and Electrolytic Capacitor Tests, the performance tests of UL 1004-1 are not applicable.

l) The marking requirements of Section 43 of UL 1004-1 are not applicable except for Manufacturer's name or identification; Rated voltage; Rated frequency, If greater than 1, number of phases; and a multi-speed motor, other than a shaded-pole or a permanent-split-capacitor motor, shall be marked with the amperes and horsepower at each speed.

27.2 Motor overload protection

27.2.1 All units

27.2.1.1 All units shall be provided with running overcurrent and locked rotor protection.

27.2.1.2 A thermal or overcurrent protective device shall not open the circuit during the intended temperature test.

27.2.1.3 A fuse shall not be used as a motor-overload-protective device unless the motor is protected by the time-delay fuse of the largest ampere rating that can be inserted into the fuseholder.

27.2.1.4 If a system of fuses is used for running-overload protection, a fuse shall be located in each ungrounded conductor, and if the motor is intended for connection to a 3-wire, 3-phase, alternating-current supply with one conductor grounding, a fuse shall also be provided in the grounded conductor.

27.2.2 Units for use on single-phase supplies

27.2.2.1 A unit shall incorporate thermal or overcurrent protection that complies with both the running overcurrent and locked rotor protection requirements in 27.2.2.2.

Exception No. 1: A shaded-pole motor with a 2:1 or smaller ratio between locked-rotor and no-load currents and a 1-ampere or smaller difference between no-load and locked-rotor currents is determined to have acceptable overcurrent resistance when it is made resistant to locked-rotor conditions only.

Exception No. 2: Units provided with power conversion equipment to convert a single-phase supply to power a three-phase motor shall be provided with motor overload protection in accordance with 27.2.3.3.

27.2.2.2 The overload protection required by 27.2.2.1 shall consist of one of the following:

a) Integral thermal or overcurrent protection that complies with both the running overcurrent and locked rotor protection requirements in the Standard for Thermally Protected Motors, UL 1004-3; or

b) Electronic protection that complies with the requirements of the Standard for Electronically Protected Motors, UL 1004-7; or

c) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2; or.

d) Circuits that provide the equivalent protection required by UL 1004-3 that comply with the Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General

Requirements, UL 60730-1. If software is relied upon to perform a Safety Critical Function, it shall be considered software Class B; or

e) Circuits that provide equivalent protection required by UL 1004-3 that comply with the circuit requirements in Supplement SA.

27.2.3 Units for use on 3-phase supplies

27.2.3.1 Units intended for use on 3-phase supplies shall either comply with the running overcurrent and locked rotor protection requirements specified in 27.2.2.2 or as specified in 27.2.3.2 – 27.2.3.5.

27.2.3.2 Permanently-connected units where the motor overtemperature protection required by Part III of Article 430 of the National Electrical Code (NEC), ANSI/NFPA 70, is intended to be provided by a separate overload device or control shall be provided with running overcurrent and locked rotor protection as specified in 27.2.3.3 – 27.2.3.5.

Exception: A Permanently-Connected Unit marked in accordance with 53.24 is not required to comply with this requirement

27.2.3.3 The motor overload protection required by 27.2.3.2 shall consist of the following:

a) Three properly rated overload units or

b) Thermal protectors, combinations of thermal protectors and overload units, or other methods of protection may be acceptable if the specific protective arrangement used has been investigated and found to provide protection under primary single-phase breakdown conditions when supplied from transformers connected wye-delta or delta-wye. An assembly so investigated shall be marked to indicate that the motor is protected under primary single-phasing conditions. This marking may be a paper sticker or decal, or may be on an attached wiring diagram.

c) Electronic overcurrent protection complying with 27.2.3.4 as part of a motor-drive complying with the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1.

27.2.3.4 A separate device incorporated in a pump in accordance with the requirements in 27.2.3.3(b), shall be responsive to motor current and shall be rated or set in accordance with Table 27.1 (column A).

Exception: If the rating of the device determined in accordance with Table 27.1 (column A) does not correspond to a standard size or rating of fused, nonadjustable circuit breakers, thermal cutouts, thermal relays, or heating elements of thermal-trip motor switches, or is not sufficient to start the motor or carry the load, a device of the next higher size, rating, or setting may be used, provided the trip current does not exceed the value specified in of Table 27.1 (column B). For a multispeed motor, each winding connection is to be considered separately.

Table 27.1
Rating or setting of overload-protective devices

Type of motor and marking	Maximum ampere rating of device as a percentage of motor full-load-current rating,	
	A	B
Motor with marked service factor of 1.15 or more, or with marked temperature rise of 40°C (72°F) or less[a]	125	140
Other motors	115	130

[a] Motor manufacturer's applied marking.

27.2.3.5 With reference to the requirements in 27.2.3.4, each winding connection of a multispeed motor shall be considered separately.

28 Overcurrent Protective Devices

28.1 A protective device, such as a fuse, whose functioning requires renewal or replacement, shall be in a readily accessible location.

28.2 A fuseholder shall be constructed and installed so that no uninsulated live part other than the screw shell will be exposed to contact by persons removing or replacing fuses.

28.3 Fuseholders shall either 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.

28.4 The screw shell of a plug type fuseholder and the accessible contact of an extractor fuseholder shall be connected toward the load.

28.5 A motor or power transformer in a unit rated at more than 16 amperes shall be protected by an overcurrent device having a maximum ampere rating in accordance with the National Electrical Code, ANSI/NFPA 70. Such overcurrent protection shall be provided as a part of the unit unless it is determined that equivalent overcurrent protection is incorporated as the branch circuit protective device.

28.6 The overcurrent protection specified in 28.4 shall be of a type suitable for branch circuit protection. When a fuse is used, it shall be a standard Class CC, G, H, J, K, RK, or T cartridge fuse or Type S or Edison-base plug fuse.

28.7 Fuses specified in 28.5 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.

29 Switches and Controls

29.1 A switch or other control device shall have a current and voltage rating not less than that of the circuit (load) that it controls. The voltage and current rating shall also correspond with the type of load controlled.

29.2 A switch or other device that controls a motor, unless interlocked so that it never has to break the locked-rotor motor current, shall be subjected to the overcurrent test specified in the Switch Test, Section 46.

29.3 A through-cord switch is not to be used.

29.4 A switch that controls a medium-base lampholder of other than a pilot- or indicating-light shall be rated for use with tungsten-filament lamps.

29.5 A cord- and plug-connected unit using a motor rated more than 1/3 horsepower (249 W output) shall contain a manually-operated motor control switch.

Exception: A permanently-connected unit with a maximum 3-foot (0.91-m) long power supply cord is not required to be provided with a motor control switch.

29.6 Switches shall comply with the Standard for General-Use Snap Switches, UL 20, or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

29.7 Switches that comply with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, shall be rated as specified in 29.8 – 29.10.

29.8 Power switches shall be rated as follows:

a) For a voltage not less than the rated voltage of the appliance;

b) For a current not less than the rated current of the appliance;

c) For Continuous Duty;

d) With respect to load:

1) Switches for motor-operated appliances: for resistance and motor load in accordance with 7.1.2.2 of Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or Outline of Investigation for Particular Requirements for Switches for Tools, UL 6059, if the switch would encounter this load in normal use; or

2) Switches may be regarded as switches for a declared specific load in accordance with 7.1.2.5 of UL 61058-1, or UL 6059, and may be classified based upon the load conditions encountered in the appliance under normal load.

e) For ac if the appliance is rated for ac;

f) For dc if the appliance is rated for dc.

29.9 Ratings and load classifications for switches other than power switches shall be based on the conditions encountered in the appliance under normal load.

29.10 Switches shall also be rated with respect to endurance as follows:

a) Power switches: 6000 cycles;

b) Power switches provided with series electronics shall be subject to an additional 1000 cycles of operation with the electronics bypassed;

c) Switches other than power switches, such as speed selector switches, that may be switched under electrical load: 1000 cycles;

d) The following non-power switches are not required to be rated for endurance:

1) Switches not intended for operation without electrical load, and which can be operated only with the aid of a tool or are interlocked so that they cannot be operated under electrical load; or

2) Switches for 20 mA load as classified in Clause 7.1.2.6 of Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

29.11 Electronic motor drives, if provided, shall be suitable for the pump voltage and current rating and shall comply with one of the following:

a) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; or

c) The circuit requirements in Supplement SA.

29.12 Electronic motor drives that additionally provide motor overload protection shall comply with 27.2.2.2.

29.13 Relays shall be suitable for the voltage, current and type of load controlled and shall comply with the Standard for Industrial Control Equipment, UL 508.

29.14 Controls shall comply with either the Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1, or the requirements in Supplement SA. Any control or circuit function 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. See Section 5 for the most common Safety Critical Functions anticipated by this standard.

30 Capacitors

30.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across-the-line (such as a capacitor for radio-interference elimination or power-factor correction) shall be housed within an enclosure or container that protects the plates against mechanical damage and reduces the risk of the emission of flame or molten material resulting from malfunction of the capacitor. The container shall be of metal providing strength and protection not less than that of uncoated steel having an average thickness of 0.020 inch (0.51 mm). Sheet metal having an average thickness less than 0.026 inch (0.66 mm) is not to be used.

Exception No. 1: The individual container of a capacitor shall be of thinner sheet metal or shall be of material other than metal when the capacitor is mounted in an enclosure that houses other parts of the unit and when such a box, case, or the like is rated for the enclosure of current-carrying parts.

Exception No. 2: The individual enclosure of an electrolytic capacitor with means for venting is required to be made resistant to mechanical damage only; the requirement for minimum enclosure thickness does not apply. The individual enclosure of an electrolytic capacitor not provided with means for venting, and with an opening more than 1/16 inch (1.6 mm) wide between the capacitor enclosure and the motor, is not required to comply with the requirement for enclosure thickness when it complies with the following. Several samples of the capacitor, mounted in the usual manner and with cotton placed around openings in the enclosure, are subjected to such overvoltage as to cause a fault condition. Whenever the cotton ignites, the results are not acceptable.

30.2 When a capacitor that is not a part of a capacitor motor or a capacitor-start motor is connected in a unit so that capacitor malfunction results in a risk of electric shock, thermal or overcurrent protection shall be provided in the unit to reduce such risk.

30.3 A capacitor containing a liquid or wax dielectric medium other than askarel shall comply with the Standard for Capacitors, UL 810, and shall be rated for the voltage to which it is connected.

31 Lampholders and Receptacles

31.1 A lampholder for a low-voltage (for example, 6-volt) lamp shall not be tapped across a part of a winding of a motor when the rating of the motor is more than 230 volts.

31.2 An attachment plug receptacle intended for general use shall be of the grounding type. Such receptacles shall be provided only in permanently-installed units and located where inaccessible to water.

31.3 A receptacle provided for general use shall be suitable for the voltage and current involved and shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

31.4 Lampholders shall comply with the Standard for Lampholders, UL 496.

31.5 Internal plugs and connectors shall be suitable for voltage and current involved and not exceed the operating temperature rating of the component.

32 Electrolytic Chlorinators

32.1 An electrolytic chlorinator shall be provided with a grounding electrode at both the water inlet and outlet points, and the electrode shall be in contact with the water, or an alternative construction complying with the requirements in 32.4 shall be provided.

32.2 The enclosure of an electrolytic cell, and the grounding electrodes at the water inlet and outlet shall be factory bonded to the point of connection of the grounding terminal for field connection for the control equipment.

32.3 The power transformer of an electrolytic chlorinator shall be provided with a conductive shield between the primary and secondary windings, or the primary and secondary windings shall be wound on separate legs of the core. In either case, the shield or the core shall be bonded to the point of connection of the equipment grounding conductor.

32.4 There shall be no voltage drop in the water in the cell of an electrolytic chlorinator as measured between the water inlet and outlet, nor shall there be a flow of current, either alternating or direct, in excess of 1 milliampere from the water to ground.

PERFORMANCE

33 General

33.1 Each test shall be made with the unit connected to a power supply circuit of rated frequency and voltage as indicated in Table 33.1, and protected by a branch circuit protective device rated in accordance with the branch circuit with which it is intended to be used.

Table 33.1
Test voltages

Rated voltage of appliance	Test voltage
1. A single voltage within any of the nominal ranges: 110 – 120, 220 – 240, 254 – 277, 440 – 480, or 550 – 600 volts	The highest voltage of the nominal range
2. A range of voltages, the highest of which falls within one of the ranges in item 1	The highest voltage of the nominal range
3. A single value not within any of the ranges in item 1	The rated voltage
4. A range of voltages, the highest of which is not within one of the ranges in item 1	The highest voltage of the rated range

34 Leakage Current Test

34.1 A cord- and plug-connected unit shall be subjected to a leakage current test in accordance with 34.2 – 34.5. The results are in compliance when:

a) For a double-insulated unit, the leakage current does not exceed:

1) 0.5 milliampere to an accessible metal part or to metal foil tightly wrapped in contact with an outer enclosure of insulating material; and

2) 3.5 milliamperes to the grounding pin of the attachment plug.

b) For a unit that is not double insulated, the leakage current to ground does not exceed 0.75 milliampere.

34.2 Leakage current refers to all currents, including capacitively coupled currents, conveyed between exposed conductive surfaces of a unit and ground or other exposed surfaces of the unit.

34.3 All exposed conductive surfaces are to be tested for leakage current. Leakage current from these surfaces is to be measured to the grounded supply conductor individually as well as collectively when simultaneously accessible, and from one surface to another when simultaneously accessible. A part is

determined to be exposed unless it is guarded by an enclosure that is intended for protection against the risk of electric shock. Surfaces are determined to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that do not involve a risk of electric shock. When all accessible surfaces are bonded together and connected to the grounding conductor of the power supply cord, the leakage current is to be measured between the grounding conductor and the grounded supply conductor.

34.4 When a conductive surface other than metal is used for an enclosure or part of an enclosure, leakage current is to be measured using a metal foil with dimensions of 10 by 20 centimeters in contact with the surface. When the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the unit.

34.5 The measurement circuit for leakage current is to be as illustrated in Figure 34.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement shall indicate the same numerical value for a particular measurement as the defined instrument; it is not required to have all the attributes of the defined instrument.

a) The meter is to have an input impedance of 500 ohms resistive shunted by a capacitance of 0.45 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of impedance of a 500 ohm resistor shunted by a 0.45 microfarad capacitor. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

34.6 Unless the meter is being used to measure leakage from one part of a unit to another, it is to be connected between accessible parts and the grounded supply conductor.

34.7 A sample of a unit is to be tested for leakage current starting with the as-received condition – the as-received condition being without prior energization, except that which occurs as part of the production-line testing. The supply voltage is to be adjusted to rated voltage. The test sequence, with reference to the measurement circuit (Figure 34.1) is to be as follows:

a) With switch S1 open, the unit is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2, and with the switching devices of the unit in all their intended operating positions.

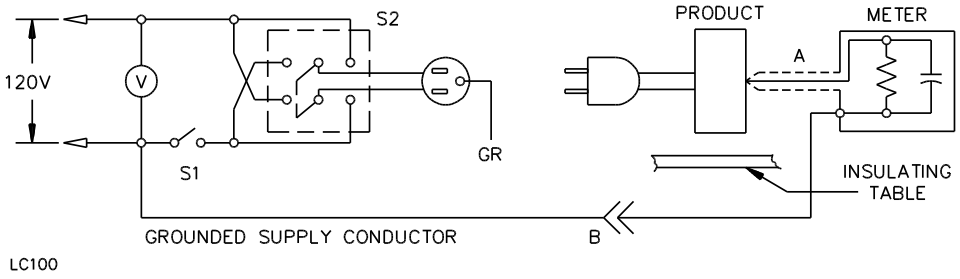
b) Switch S1 is then to be closed, energizing the unit, and within 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the switching devices of the unit in all their intended operating positions.

c) Leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation as in the normal temperature test.

34.8 Normally a sample is carried through the complete leakage current test, as specified in 34.7, without interruption for other tests. With the concurrence of those concerned, the leakage current test is not prohibited from being interrupted to conduct other nondestructive tests.

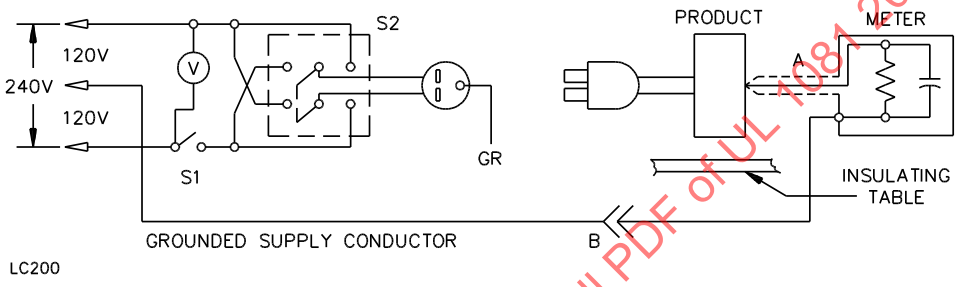
Figure 34.1

Leakage-current measurement circuits



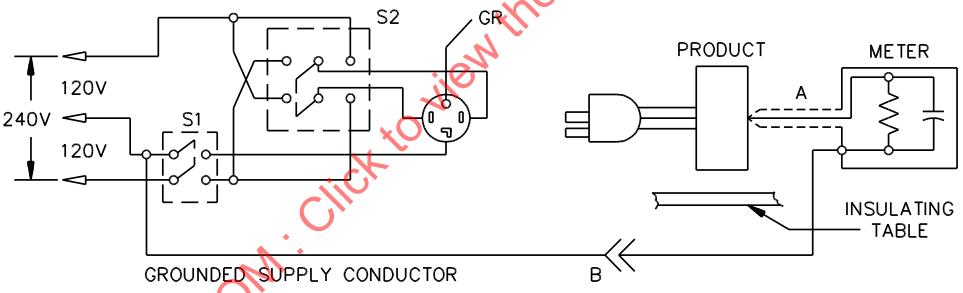
LC100

Product intended for connection to a 120-volt power supply.



LC200

2-wire appliance intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



LC300

3-wire appliance intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

A – Probe with a shielded lead.

B – Separated and used as a clip when measuring currents from one part of a product to another.

35 Starting Current Test

35.1 A unit shall be capable of starting and operating as intended on a circuit protected by a non-time-delay branch circuit fuse having a current rating corresponding to that of the branch circuit to which the unit is intended to be connected.

Exception: The requirement does not apply when:

a) The construction of the unit or the nature of its usage is such that it is used continually on the same branch circuit after installation;

b) The unit starts and operates as intended on a circuit protected by a time delay fuse; and

c) The unit is marked in accordance with 53.7.

35.2 In a test to determine whether a unit complies with the requirement in 35.1, the unit is to be started three times, with the unit at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of intended operation (the beginning of the intended operating cycle, in the case of an automatic unit) and the motor is to be allowed to come to rest between successive starts. The performance is not in compliance when the fuse opens. Tripping of an overcurrent protector provided as part of the unit is also considered to constitute malfunction.

36 Power Input Test

36.1 The current input to a unit shall be not more than 110 percent of the rated value when the unit is operated under the condition of maximum intended load as described in 36.2, and when connected to a supply circuit as specified in 33.1.

36.2 The maximum intended load for a unit is to be considered that load adjusted as much as it is possible to produce the maximum input current at a given voltage. For a pump or a pump-filter combination, this is an operation using the equipment provided with the pump that results in maximum input with or without the filter elements. For an electrolytic type chlorinator, this is the addition of electrolyte to produce maximum rated current output. For a permanently-connected pump or pump-filter combination, maximum input for all conditions from open outlet to closed outlet is determined.

37 Grounding Continuity Test

37.1 Compliance with the requirements in 14.3.3 shall be determined by any indicating instrument (ohmmeter or bridge); however, when results not in compliance are recorded, an alternating current of at least 30 amperes from a power supply of not more than 12 volts is to be passed from the point of connection of the equipment grounding means to the metal part of the grounding circuit, and the resulting drop in potential is to be measured between the two points. The resistance in ohms is to be determined by dividing the drop of the potential in volts by the current in amperes passing between the two points. The grounding conductor of the power supply cord is not included in this measurement.

38 Temperature Test

38.1 A unit shall be subjected to the temperature test described in 38.2 – 38.9 under the conditions of maximum intended load as described in 36.2. The temperature at any point shall not be sufficiently high to constitute a risk of fire or to damage any materials used in the unit, and the maximum temperature at specific points shall not be higher than the temperatures specified in Table 38.1.

38.2 Coil or winding temperatures are to be measured using thermocouples unless the coil is inaccessible for mounting of these devices (for example, a coil encapsulated in sealing compound) or

unless the coil wrap includes thermal insulation or more than two layers, 1/32 inch (2.4 mm) maximum of cotton, paper, rayon, or the like, in which case the change-of-resistance method may be used. For a thermocouple measured temperature of a coil of an alternating-current motor, other than a universal motor, having a diameter of 7 inches (178 mm) or less (item A, subitems 1, 3, and 5 of Table 38.1), the thermocouple is to be mounted on the integrally-applied insulation on the conductor.

38.3 The temperatures specified in Table 38.1 are based on an assumed ambient temperature of 25°C (77°F). However, the test may be conducted within the range of 10°C – 40°C (50°F – 104°F) when the temperature is corrected to 25°C. When a corrected temperature exceeds the value specified in Table 38.1, the test is not prohibited from being repeated at an ambient closer to 25°C at the request of the manufacturer.

38.4 When the unit incorporates a reel for the power supply cord, one-third of the length of the cord is to be unreeled for the temperature test.

38.5 Temperatures, other than as noted in 38.2, are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2).When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer type instrument; such equipment is used whenever referee temperature measurements by thermocouples are required. The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to conform with the requirements for special tolerances thermocouples as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M. The thermocouples are to be waterproof when they are intended to be immersed in water during testing.

38.6 A thermocouple junction and the adjacent thermocouple lead wire are to be held in thermal contact with the surface of the material whose temperature is being measured. In most cases, thermal contact results from taping or cementing the thermocouple in place but, when a metal surface is involved, brazing or soldering of the thermocouple to the metal may be required.

38.7 Unless the unit is obviously not intended for continuous operation, this test is continued until constant temperatures are attained. Thermal equilibrium is considered to exist when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no change.

38.8 A pump intended for swimming pool use only and marked in accordance with 53.18 shall be tested while pumping 25°C (77°F) water.

Table 38.1
Maximum temperatures

Materials and components	°C	(°F)
A. MOTORS		
1. Class 105 insulation systems on coil windings of an AC motor having a diameter of 7 inches (178 mm) or less, not including a universal motor, and of a vibrator coil[a]		
a) In an open motor and on a vibrator coil:		
Thermocouple or resistance method	100	(212)
b) In a totally enclosed motor:		
Thermocouple or resistance method	105	(221)

Table 38.1 Continued on Next Page

Table 38.1 Continued

Materials and components	°C	(°F)
2. Class 105 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b) In a totally enclosed motor:		
Thermocouple method	95	(203)
Resistance method	105	(221)
3. Class 130 insulation systems on coil windings of an AC motor having a diameter of 7 inches or less, not including a universal motor[a]		
a) In an open motor:		
Thermocouple or resistance method	120	(248)
b) In a totally enclosed motor:		
Thermocouple or resistance method	125	(257)
4. Class 130 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	110	(230)
Resistance method	120	(248)
b) In a totally enclosed motor:		
Thermocouple method	115	(239)
Resistance method	125	(257)
5. Class 155 insulation systems on coil windings of an AC motor having a diameter of 7 inches or less, not including a universal motor[a]		
a) In an open motor:		
Thermocouple or resistance method	145	(293)
b) In a totally enclosed motor:		
Thermocouple or resistance method	150	(302)
6. Class 155 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	135	(275)
Resistance method	145	(293)
b) In a totally enclosed motor:		
Thermocouple method	140	(284)
Resistance method	150	(302)
B. COMPONENTS		
1. Capacitors		
a) Electrolytic[b, c]	65	(149)
b) Other types[c]	90	(194)
2. Fuses		
Classes G, J, L, T, and CC:		

Table 38.1 Continued on Next Page

Table 38.1 Continued

Materials and components	°C	(°F)
Tube	125	(257)
Ferrule or blade	110	(230)
Others[d]	90	(194)
3. Relay, solenoid, and coils (except motors and transformers) with		
a) Class 105 insulation system:		
Thermocouple method	90	(194)
Resistance method	110	(230)
b) Class 130 insulation systems:		
Thermocouple method	110	(230)
Resistance method	130	(266)
4. Sealing compound	e	e
5. Transformers		
a) Class 105 insulation system:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b) Class 130 insulation system:		
Thermocouple method	110	(230)
Resistance method	120	(248)
C. CONDUCTORS		
1. Rubber- or thermoplastic-insulated wires and cords[d]	60	(140)
2. Copper conductors		
a) Tinned or bare strands having:		
A diameter less than 0.015 inch (0.38 mm)	150	(302)
A diameter of 0.015 inch or more	200	(392)
b) Plated with nickel, gold, silver, or a combination of these	250	(482)
3. Termination of copper conductor in a pressure terminal connector unless both are tinned, nickel coated, or silver plated	150	(302)
D. ELECTRICAL INSULATION – GENERAL		
1. Fiber used as electrical insulation	90	(194)
2. Phenolic composition used as electrical insulation or as a part, the deterioration of which results in a risk of fire or electric shock		
a) Laminated	125	(257)
b) Molded	150	(302)
3. Varnished-cloth insulation	85	(185)
E. OTHER		
1. Wood and other combustible material	90	(194)
2. At any part within a terminal box or wiring compartment of a permanently connected unit[f]	60	(140)
3. A surface upon which a stationary unit is mounted in service, and surfaces that are adjacent to the unit when so mounted	90	(194)

[a] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by means of a thermocouple may be more than the maximum temperature specified in this table when the temperature, as measured by the resistance method, is not more than that specified. The temperature measured by means of a thermocouple may be more than the specified value by:

Table 38.1 Continued on Next Page

Table 38.1 Continued

Materials and components	°C	(°F)
1) 5°C (9°F) for Class 105 insulation systems on coil winding of alternating-current motors, open type; and 2) 10°C (18°F) for Class 130 or Class 155 (Class F) insulation systems on coil windings of alternating-current motors, open type. [b] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum temperature on vulcanized fiber barriers integral with the capacitor enclosure may not be more than 90°C (194°F). Other barrier materials may be accepted that comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. [c] A capacitor that operates at a temperature of more than 90°C (194°F) may be investigated on the basis of its marked temperature limit. [d] A component that has been investigated and determined to function without risk of fire at a higher temperature may be used at that temperature. [e] Unless a thermosetting material, the maximum temperature of the sealing compound shall not be more than 15°C (27°F) below the softening point of the compound as determined by the Test for Softening Point by Ring-and-Ball Apparatus, ASTM E 28, when corrected to a 25°C (77°F) ambient temperature. [f] A unit provided with a terminal box or wiring compartment that attains a temperature higher exceeding 60°C (140°F) shall be marked as specified in 53.16.		

38.9 A pump intended for permanent installation that is intended for swimming pool and hot tub and spa use shall be tested pumping 50°C ±3°C (122°F ±5°F) water.

Exception: The test is not prohibited from being conducted pumping 25° C (77° F) water when the construction of the pump is such that heat from the water does not affect the temperature of the motor windings. Pumps other than the "close-coupled" design are considered to be constructed such that motor winding temperatures are not affected by the temperature of the fluid being pumped.

39 Dielectric Voltage-Withstand Test

39.1 Double-insulated units

39.1.1 A double-insulated unit shall be tested in accordance with 39.3.1 and Table 39.1. The results are in compliance when there is no dielectric breakdown.

Table 39.1
Dielectric voltage-withstand potential for storable, cord-connected units

Potential applied between	Unit type	Unit rating, horsepower (W)		volts	Test potential, volts
1. A live part and a grounded-metal part	Pump or pump filter	1/2 (373)	or	250 or less	1000
		Over 1/2	or	over 250	1000 plus twice rated voltage
2. Grounded metal and accessible noncurrent-carrying metal[a]	Any	Any		Any	2000 plus twice rated voltage
3. Grounded metal and water	Any	Any		Any	2000 plus twice rated voltage
4. Accessible noncurrent-carrying metal[a] and metal foil in contact with the inner surfaces of insulating barriers	Any	Any		Any	2000 plus twice rated voltage

Table 39.1 Continued on Next Page

Table 39.1 Continued

Potential applied between	Unit type	Unit rating, horsepower (W)	Unit rating, volts	Test potential, volts
provided to comply with the requirement specified in 18.6				
5. Accessible noncurrent-carrying metal[a] and				
A. Metal foil wrapped around the power supply cord inside the inlet bushings, cord guards, strain relief clamps, and the like or	Any	Any	Any	2000 plus twice rated voltage
B. A metal rod of the same cross-sectional dimensions as the cord and inserted in its place	Any	Any	Any	2000 plus twice rated voltage

NOTES

1 This table applies to units that are double-insulated, grounded, provided with a minimum 25-foot (7.6 m) cord, and intended for use with storable pools.

2 See also 40.1.3 for order of tests.

[a] When the outer enclosure, the pump casing, or both is of insulating material, it is to be tightly wrapped in metal foil for this test, and the foil is to be the accessible metal. The foil is to be connected to a copper electrode consisting of two turns of bare 14 AWG (2.1 mm^2) solid copper wire wound tightly together to form a ring with an outside diameter of 3/4 inch (19.1 mm). The electrode is to be in contact with the water being pumped; the point of contact is to be the point nearest to the pump housing at which a user can contact the water. During the test, any removable hose or pipe extensions are to be disconnected.

39.2 All other units

39.2.1 A unit that is not double insulated shall be tested in accordance with 39.3.1 and Table 39.2. The results are in compliance when there is no dielectric breakdown.

Table 39.2
Dielectric voltage-withstand potential for permanently-connected units

Potential applied between	Unit type	Unit rating, horsepower (W)	Unit rating, volts	Test potential, volts
Live parts of a primary or line voltage part and noncurrent-carrying metal	Any	1/2 (373) or less	and 250 or less	1000
		Over 1/2 or over 250		1000 plus twice rated voltage
Primary and secondary low voltage coils of a transformer	Electrolytic chlorinator	Any	Any	2500
Secondary low voltage coil of transformer and noncurrent-carrying metal	Electrolytic chlorinator	Any	Any	500

NOTE– This table applies to units with wiring terminals or leads, or provided with a maximum 3-foot (0.9 m) cord, and intended for use with permanently installed pools.

39.3 Method

39.3.1 To determine compliance with the requirements in 39.1.1 and 39.2.1, while at the maximum operating temperature reached during intended use, a unit is to be tested by means of a 60-hertz, 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied. As an alternate, a direct current output voltage equivalent to 1.414 times the 60-hertz value may be used.

Starting at zero, the applied potential is to be increased gradually until the required test value is reached, and is to be held at that value for 1 minute.

40 Water Exposure Test

40.1 General

40.1.1 A unit shall resist certain conditions of exposure to water without introducing the risk of electric shock due to current leakage or insulation breakdown. A unit shall be subjected to water exposure, flooding, and reverse siphoning.

Exception: A unit not provided with hose connections is not required to be subjected to the flooding test.

40.1.2 A separate sample shall be used for any water resistance test.

40.1.3 Following each of the water resistance tests, and before the reverse siphoning described in 40.4.2, the following tests shall be conducted:

a) The Dielectric Voltage-Withstand Test, Section 39, and

b) For a cord-connected unit, the Leakage Current Test, Section 34.

Exception No. 1: The dielectric voltage-withstand test for double-insulated units following the operation described in 40.4.1, and the siphoning described in 40.4.2, is to be conducted at 1000 volts from grounded metal to exposed metal, and to water being pumped.

Exception No. 2: A permanently-connected unit that has all electrical components completely enclosed in a compartment without openings, separate from the pump volute or other water handling parts, is not required to be subjected to the flooding or siphoning test.

40.1.4 In the tests specified in 40.2.1 – 40.2.3, the water is to have a resistivity of 2540 ohm-centimeters. In the test specified in 40.3.1 – 40.4.2, the water is to have a resistivity of 300 ohm-centimeters.

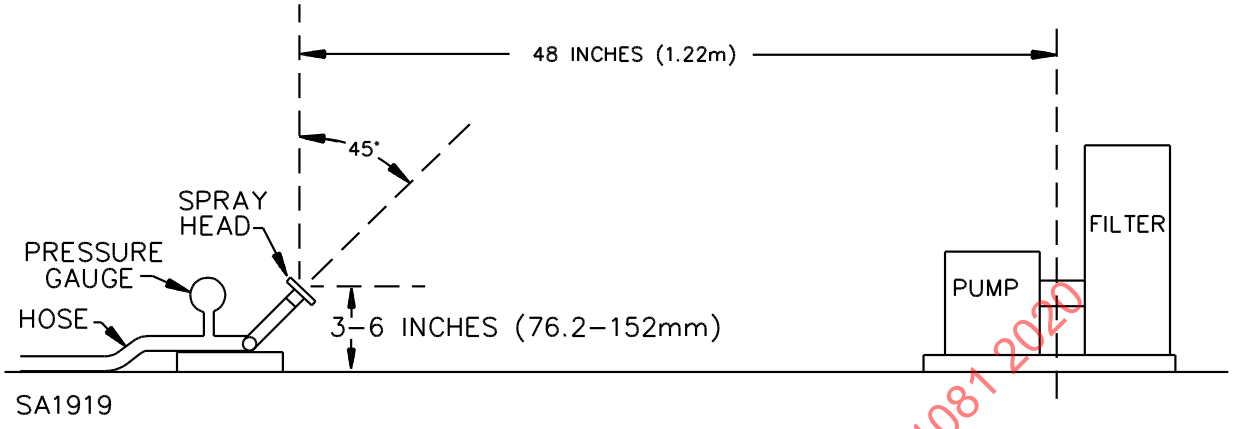
40.2 Water exposure

40.2.1 A unit shall be subjected to a water exposure test representing the effects of rain or splashing from an adjacent swimming pool, as described in 40.2.2 and 40.2.3.

40.2.2 The unit is to be placed, as illustrated in Figure 40.1, on a horizontal plane. The complete appliance is to be tested, or the test is to be conducted, on a filter-pump combination with the filter container removed, whichever condition is more severe.

Figure 40.1

Water exposure apparatus



40.2.3 A single nozzle of the type described in Figure 40.2 is to be aligned to place the center of the nozzle head 48 inches (1.22 m) from the centerline of the unit and 3 to 6 inches (76.2 to 152 mm) above the level of the supporting surface for the appliance. A water pressure of 20 psig (137.9 kPa) is to be maintained during the test. The sample is to be located in the position most likely to cause wetting of live parts, and is to be subjected to the water spray for 4 hours. Drains are to be provided in the test area so that the water does not accumulate. During the test, the sample is to be operated pumping water.

40.2.4 Upon completion of the test and after the electrical tests have been conducted, the interior of the equipment is to be inspected to determine that there is no wetting of live parts or insulation.

40.3 Flooding

40.3.1 A unit is to be operated for 1 hour with any one hose loosened or disconnected to produce the maximum flooding of the appliance. Drains are to be provided in the test area so that the water does not accumulate.

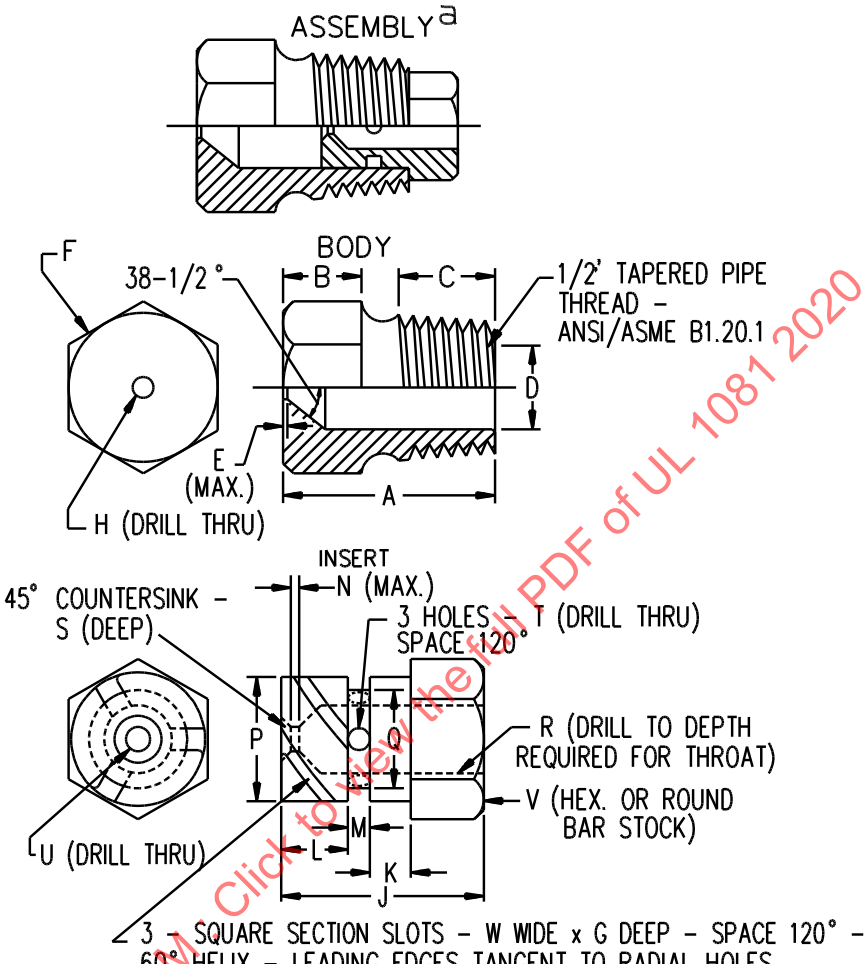
40.4 Reverse siphoning

40.4.1 A pump or pump-filter combination shall be operated dry for 7 hours or, for seal types that can be so treated, with the seal face scored with a triangular file to a depth of 1/16 inch (1.6 mm) in two locations to simulate the condition of a shaft seal at end-of-life, followed by 1 hour of operation.

40.4.2 Following the 1-hour operation specified in 40.4.1, the pump shall stand for 1 hour under such conditions of reverse siphoning from the test pool as the damaged seal permits.

Figure 40.2

Spray head assembly



Item	inch	mm	Item	inch	mm
A	1 7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35) [b]	2.80
H	(No.9) [b]	5.0	U	(No. 40) [b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

RT100E

41 Resistance to Ultraviolet Light and Water Test

41.1 In accordance with 7.6, a determination shall be made of the effect of ultraviolet light and water on the life of essential properties of a polymeric enclosure or exposed polymeric part that serves to support or mount electrical equipment, or is otherwise necessary to reduce the risk of fire, electric shock, or injury to persons. Testing shall be in accordance with the Ultraviolet Light Exposure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

42 Resistance to Impact Test

42.1 The impact resistance of the enclosure of a unit shall be investigated in accordance with 42.2 – 42.5. The results are in compliance when the unit withstands the impact described in 42.2 without:

a) Reducing spacings below the minimum required values;

b) Making accessible to contact:

1) Live parts and,

2) When applicable, noncurrent-carrying metal parts that are insulated from live parts by a single primary insulation only;

c) Introducing breakage, cracking, rupture, or the like, such as to produce an adverse effect on the insulation; and

d) Producing any other condition that increases the risk of electric shock.

42.2 The unit is to be subjected to an impact of 5 foot-pounds (6.8 J) on any surface that is exposed to a hit or impact during use. This impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (0.54 kg), from the height that produces the specified impact. When the impact is incapable of being produced on the desired surface by means of a vertical drop, the sphere shall be swung as a pendulum to produce a side wall impact of 5 foot-pounds.

Exception: The impact value for an enclosure of nonmetallic material that has been tested in accordance with the Resistance to Ultraviolet Light and Water Test, Section 41, and that has exhibited a resistance to impact, after exposure to ultraviolet light and water for the maximum test period, of at least 50 percent but less than 70 percent of the as-received value, is to be subjected to an impact of 10 foot-pounds (13.6 J). An enclosure of a material exhibiting a resistance to impact after exposure for the maximum test period of at least 25 percent but less than 50 percent of the as-received value is to be subjected to an impact of 20 foot-pounds (27.2 J).

42.3 A switch handle, knob, operating button, or the like consisting of a metal insert covered with an exterior layer of insulating material that is needed to comply with the requirements in this standard, shall be subjected to the impact specified in 42.2. The results are in compliance when there is no cracking or breaking of the insulating material (or the inner layer of insulation, if there is more than one layer) or dislodging of the handle from its intended position.

42.4 A switch handle, knob, operating button, or the like, consisting entirely of insulating material that is needed to comply with the requirements in this standard, shall be subjected to the impact specified in 42.2. The results are in compliance when the handle is not dislodged from its intended position.

Exception: The requirement does not apply when, with the handle completely removed from the switch, no live parts and no previously inaccessible noncurrent-carrying metal parts are accessible.

42.5 In a determination of whether a switch handle or the like complies with the requirements in 42.3 or 42.4 (whichever applies), two samples are to be tested. These tests are to be conducted in addition to those required in 42.1 and 42.2, and before the water exposure and flooding tests and the dielectric voltage withstand and leakage current tests. The switch becoming inoperative is considered to be acceptable.

43 Abnormal Operation Test

43.1 An electrolytic type chlorinator shall be continuously operated while subjected to the use of excessive amounts of electrolyte or the flowing or interruption of water flow through the electrolytic cell.

43.2 The chlorinator shall be operated in the same manner as in the temperature test; however, adjustments of water flow and concentration of electrolyte that are necessary to determine the ultimate effect shall be made. The results are in compliance when there is no risk of fire or electric shock, and if excessive concentrations of noxious or flammable gases are not produced.

44 Hydrostatic Pressure Test

44.1 If a test is necessary to determine compliance with 26.1, two samples of the part are to be subjected to a hydrostatic pressure test. Each sample is to be filled with water so as to exclude air and is to be connected to a hydraulic pump. The pressure is to be raised gradually to a value of 1.5 times the maximum pressure that the pump can develop on the part and is to be held at that value for 1 minute. The results are in compliance when the part does not burst or leak.

44.2 Leakage at a gasket during the hydrostatic pressure test is not considered to constitute malfunction unless it occurs at a pressure 40 percent or less of the required test value.

45 Strain Relief Test

45.1 When tested in accordance with 45.2, the strain relief means provided on a flexible cord shall be subjected to a direct pull of 35 pounds (156 N) applied to the cord for 1 minute, with the connections within the unit disconnected.

45.2 A 35-pound (15.9 kg) weight is to be suspended on the cord and supported by the unit so that the strain-relief means is stressed from any angle that the construction of the unit permits. The strain relief is not in compliance when, at the point of disconnection of the conductors, there is movement of the cord such as to indicate that stress has resulted on the connections.

46 Switch Test

46.1 In accordance with 29.2, a switch shall be subjected to an overcurrent test consisting of 50 cycles of operation, making and breaking the locked rotor current of the unit. The results are in compliance when there is no dielectric or mechanical malfunction of the device or pitting or burning of the contacts.

46.2 In a test to determine whether the switch or other control device can perform acceptably in the overcurrent test specified in 46.1, the unit is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage with the rotor of the motor locked in position. During the test, exposed noncurrent-carrying metal parts of the unit are to be connected to ground through a 3-ampere plug fuse, and the connection is to be such that any single-pole, current-carrying device will be located in the ungrounded conductor of the supply circuit. The device is to be operated at a rate of not more than 10 cycles per minute; however, a faster rate of operation may be used if agreeable to all concerned. The performance is in compliance when the fuse in the grounding connection does not open during the test.

47 Metallic Coating Thickness Test

47.1 In accordance with 11.8, the thickness of a zinc or cadmium coating shall be determined by the metallic coating thickness test as follows:

a) The solution to be used for the test is to be made from distilled water and is to contain 200 grams per liter of reagent grade chromic acid, CrO_3 and 50 grams per liter of reagent grade concentrated sulfuric acid, H_2SO_4. (The latter is equivalent to 27 milliliters per liter of concentrated sulfuric acid, specific gravity 1.84, containing 96 percent H_2SO_4).

b) The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube of approximately 0.025 inch (0.635 mm) inside bore and 5.5 inches (139.7 mm) long. The lower end of the capillary tube is tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

c) The sample and the test solution should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature between 21 and 32°C (70 and 90°F).

d) Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care should be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

e) The sample to be tested is to be supported from 0.7 to 1 inch (17.8 to 25.4 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested should be inclined about 45 degrees from horizontal.

f) After cleaning, the sample to be tested is to be put in place under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stop watch until the dropping solution dissolves off the protective metallic coating, exposing the base metal. The endpoint is the first appearance of the base metal recognizable by the change in color at that point.

g) Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface, and at an equal number of points on the outside surface, at places where the metallic coating may be expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

h) To calculate the thickness of the coating being tested, select from Table 47.1 the thickness factor appropriate for the temperature at which the test was conducted and multiply by the time in seconds required to expose base metal as noted in (f).

Table 47.1
Thickness factors

Temperature,		Thickness factors, 0.00001 inch (0.00025 mm) per second	
°F	(°C)	Cadmium platings	Zinc platings
70	(21.1)	1.331	0.980
71	(21.7)	1.340	0.990
72	(22.2)	1.352	1.000
73	(22.8)	1.362	1.010
74	(23.3)	1.372	1.015
75	(23.9)	1.383	1.025
76	(24.4)	1.395	1.033
77	(25.0)	1.405	1.042
78	(25.6)	1.416	1.050
79	(26.1)	1.427	1.060
80	(26.7)	1.438	1.070
81	(27.2)	1.450	1.080
82	(27.8)	1.460	1.085
83	(28.3)	1.470	1.095
84	(28.9)	1.480	1.100
85	(29.4)	1.490	1.110
86	(30.0)	1.501	1.120
87	(30.6)	1.513	1.130
88	(31.1)	1.524	1.141
89	(31.7)	1.534	1.150
90	(32.2)	1.546	1.160

48 Creep Test

48.1 A polymeric part that supports a motor shall be subjected to the test described in 48.2 and 48.3. The results are in compliance when the motor remains securely attached to the base.

48.2 When a motor and its supporting polymeric parts are intended to be mounted in the field, they are to be mounted in accordance with the instructions that accompany such a unit. All bolts or screws that are intended to be field mounted are to be tightened at the torque value specified in the instructions. When the motor and polymeric supporting parts are factory assembled, the unit is to be tested in the factory-assembled condition with the torque on the screws or bolts tightened at the upper manufacturing tolerance limit. The information on the torque value is to be provided by the manufacturer for the testing of factory assembled units.

48.3 The motor and parts are then to be placed in an air-circulating oven maintained at a temperature at least 10°C (18°F) higher than that measured on the polymeric part during the temperature test, but not less than 70°C (158°F). While in the oven, for 300 hours, the motor is to be operated through cycles, repeated at 10-minute intervals, consisting of:

a) Starting the motor;

b) Letting it reach maximum speed; and

c) Stopping the motor.

The motor is then to be removed from the oven and examined visually to determine if the means of mounting provides the necessary support under conditions of operation.

MANUFACTURING AND PRODUCTION-LINE TESTS

49 Grounding Continuity Test

49.1 As a routine production-line test, each unit that has a power supply cord having a grounding connector shall be tested for continuity between the grounding blade of the attachment plug and the inaccessible dead metal parts of the appliance that are required to be grounded. This may require testing before final assembly of the enclosure.

49.2 Any indicating device (an ohmmeter, a battery-and-buzzer combination, or the like) may be used to determine compliance with the grounding continuity requirement in 49.1.

50 Dielectric Voltage-Withstand Test

50.1 As a routine production-line test, each unit shall be subjected to a 1-second application of a 60-hertz test potential as indicated in Table 50.1. As an alternate, a direct current output voltage equivalent to 1.414 times the 60-hertz value may be used. The results are in compliance when there is no dielectric breakdown.

50.2 Factory dielectric voltage-withstand test equipment shall have such capacity as to maintain the test voltage across the insulation being tested until an indication of breakdown is produced. Such indication shall consist of an indicator light or audible indicator. It is recommended that the voltage be raised gradually on internal circuits accessible through the power supply cord, with the accessible parts of the test circuit at ground potential.

Table 50.1
Factory dielectric voltage-withstand tests

Location	Test voltage		
	Storable units[a]	Permanent units[b], 0 – 250 V	Permanent units[b], over 250 V
Line supply to grounding conductor	1200	1200	2000
Enclosure[c] to grounding conductor	1500	–	–
Line supply to enclosure[c]	2500	–	–

[a] Applies to units that are double-insulated, grounded, provided with a minimum 25-foot (7.6 m) cord, and intended for use with storable pools.

[b] Applies to units with wiring terminals or leads, or provided with a maximum 3-foot (0.9 m) cord, and intended for use with permanently installed pools.

[c] When a nonmetallic enclosure is used, test to metal foil clamped over outside.

RATINGS

51 Storable Pool Pumps

51.1 A storable pool pump shall be rated in amperes, volts, and frequency.

52 Permanently-Installed Units

52.1 A permanently-installed unit shall be rated in amperes, volts, frequency, and the number of wires required in a power supply circuit. The number of phases shall be included in the rating if the unit is for use on a polyphase circuit. The voltage rating shall be any appropriate single voltage or voltage range, such as: 110 – 120, 208, 220 – 240, 254 – 277, 440 – 480, or 550 – 600.

MARKINGS

53 Details

53.1 A unit shall be legibly and permanently marked with:

a) The manufacturer's name, trade name, or trademark;

b) The day or other dating period of manufacture not exceeding any three consecutive months;

c) A distinctive catalog or model number or the equivalent; and

d) The electrical ratings as described in Storable Pool Pumps, Section 51, and Permanently-Installed Units, Section 52.

Exception No. 1: The manufacturer's identification may be in a traceable code if the unit is identified by the brand or trademark owned by a private labeler.

Exception No. 2: The date of manufacture is not prohibited from being abbreviated or in an established or otherwise accepted code.

53.2 An alternating-current frequency indication shall be "hertz," "Hz," "cycles-per-second," "cps," "cycles/second," or "c/s."

53.3 A permanently connected unit provided with a power supply cord in accordance with the Exception to 13.1.1 shall be plainly marked where readily visible with the word "WARNING" and the following or equivalent statement: "Risk of Electric Shock. Connect Only to a Grounding Type Receptacle Protected by a Ground-Fault Circuit-Interrupter (GFCI)."

53.4 A storable pool pump shall be plainly marked where readily visible with the word "WARNING" and the following statement: "Risk of Electric Shock. Connect Only to a Grounding Type Receptacle."

53.5 When a manufacturer produces or assembles units at more than one factory, each finished unit shall have a distinctive marking, which is capable of being in code, by which it shall be identified as the product of a particular factory.

53.6 A unit of the type described in the Exception to 7.12 shall be marked with the following or the equivalent: "For permanent installation only on concrete."

53.7 When a unit does not start and attain normal running speed when connected to a circuit protected by a fuse (not a time-delay) as described in 35.1, the unit shall be plainly marked with the following or the equivalent: "If connected to a circuit protected by fuses, use time-delay fuses with this unit."

53.8 Unless the intended field wiring connections are evident, a wiring diagram shall be attached to the unit.

53.9 A paper sticker that is glued or shellacked to an accessible cover is considered to be attached to the unit in accordance with the requirement in 53.8.

53.10 A marking that is required to be plain and permanent shall be in the form of paint stenciled, die-stamped, or indelibly stamped lettering, or in a form that has been investigated and determined to be the equivalent. The determination of permanence shall be in accordance with the applicable tests specified in the Standard for Marking and Labeling Systems, UL 969. The signal words “CAUTION”, “WARNING” and “DANGER” shall be in letters at least 1/8 inch (3.2 mm) high. The remaining letters of such cautionary markings, unless specified otherwise in individual marking requirements, shall not be less than 1/16 inch (1.6 mm) high.

Exception: The markings specified in 53.21 and 53.23 are capable of being provided as cord tags formed as described in 53.10 and:

a) Permanently affixed to the power-supply cord;

b) Located not more than 6 inches (152.4 mm) from either the pump housing, the attachment plug or integral GFCI in the case of storable pool pump;

c) Made of substantial material such as cloth, plastic, or the equivalent that provides the required mechanical strength and prevents easy removal;

d) Complying with the requirements in Markings, Permanence, Section 54; and

e) Sized so that the required markings are legible, and all exposed surfaces have a clear plastic overlay, or the equivalent, to protect the markings.

53.11 The tags described in the Exception to 53.10 shall be in either of the following forms:

a) A flag-type tag having a hole to permit securement to the power-supply cord by a plastic strip or equivalent means. The strap shall not be removable without cutting.

b) A flag-type tag with an adhesive back. The tag is to be wrapped tightly once around and is to adhere to the power-supply cord. The ends of the tag are to adhere to each other and project as a flag. The required markings are to be positioned on the projecting flag portion of the tag.

53.12 A permanently-connected unit intended to be protected by a branch circuit fuse rated less than the maximum rating of the branch circuit fuse to which the unit can properly be connected in accordance with the National Electrical Code, ANSI/NFPA 70, shall be marked to indicate the maximum current rating of the branch circuit fuse for which the unit has been investigated and determined to be acceptable.

53.13 A permanently-connected unit intended for indoor use shall be marked in the following manner: "For indoor use only." The marking shall be located close to the marking required in 53.1.

53.14 An inherently thermally protected motor provided on a unit shall be marked "Thermally protected." An impedance protected motor provided on a unit shall be marked "Impedance protected."

53.15 In accordance with 13.3.3, the field terminals of a swimming pool appliance shall be marked with the following or the equivalent: "Use copper conductors only," "Use aluminum conductors only," or "For use with aluminum or copper conductors." This marking shall be independent of any marking on the connectors, and it shall be permanent and visible at the point where field terminal connections are made.

Exception: This marking is not required on terminals intended for the connection of grounding or bonding conductors.

53.16 When, during the Temperature Test, Section 38, temperatures in the field wiring compartment exceed 60°C (140°F), the wiring diagram or the point where the supply connections are to be made shall be marked: "For supply connections, use conductors sized on the basis of 60° C ampacity but rated minimum ____ °C (____ °F)." The temperature value shall be in accordance with the values specified in Table 53.1.

Table 53.1
Terminal box marking

Maximum temperature attained in terminal box or compartment during temperature test		Temperature marking
61 – 75°C	(142 – 167°F)	75°C (167°F)
76 – 90°C	(169 – 194°F)	90°C (194°F)

53.17 With regard to 7.10 and 55.4, a storable pool pump shall be marked with the word "CAUTION" and the following or equivalent wording: "For continued protection against possible electric shock this unit is to be mounted to the base in accordance with the installation instructions."

53.18 A pump tested only for swimming pool use in accordance with 38.8 shall be marked: "For Use with Swimming Pools Only."

53.19 A pump intended for permanent installation that has been investigated for swimming pool use and hot tub and spa use in accordance with 38.9, shall be marked: "For Use With Swimming Pools, Hot Tubs, and Spas" or the equivalent.

53.20 A permanently-installed unit provided with a maximum 3-foot (0.91-m) cord shall be plainly and permanently marked with the word "CAUTION" and the following or equivalent statement: "To reduce the risk of electric shock, install at least 6 feet from the inside walls of a pool. Do not use an extension cord."

53.21 A permanently-connected swimming pool pump, with or without a maximum 3-foot (0.91-m) flexible cord, shall be permanently marked with the word "CAUTION" and with the following or equivalent statement: "This Pump is for Use with Permanently-Installed Pools Only – Do Not Use with Storable Pools." The letters of the marking shall be in a color that contrasts with the background of the tag and shall be at least 1/8 inch (3.2 mm) high.

53.22 A swimming pool pump with a minimum 25-foot (7.62-m) flexible cord shall be permanently marked with the word "CAUTION" and the following or equivalent statement: "This Pump is for Use with Storable Pools Only – Do Not Use with Permanently-Installed Pools." The letters of the marking shall be in a color that contrasts with the background of the tag and shall be at least 1/8 inch (3.2 mm) high.

53.23 A storable pool pump shall be provided with a tag attached to the power-supply cord. The tag shall be plainly and permanently marked with the following wording, or the equivalent, in the format shown. No substitute shall be used for "WARNING". The words "WARNING – RISK OF ELECTROCUTION" and "DO NOT REMOVE THIS TAG" shall be in block lettering. See 54.2.

"WARNING – RISK OF ELECTROCUTION

1) Connect Only To Properly Grounded Outlet. Do Not Remove Ground Pin

2) Inspect Cord Before Using – Do Not Use If Cord Is Damaged.

3) Keep Ground-Fault Circuit-Interrupter Dry And Off The Ground

4) Do Not Touch Plug With Wet Hands

5) Double Insulated – When Servicing Use Only Identical Replacement Parts.

6) Read Instruction Manual Before Using.

DO NOT REMOVE THIS TAG"

53.24 A pump not provided with motor protection in accordance with the Exception to 27.2.3.2 shall be marked:

a) To indicate that motor protection must be provided by the installer and

b) With all motor ratings and information necessary for proper selection of protection by the installer.

53.25 Units intended to meet Exception No. 1 of 13.1.9 shall be marked where visible after installation and in the Installation Instructions to indicate they are for use only with flexible wiring systems. The letters of the marking shall be not less than 1/16 inch (1.6 mm) high.

53.26 Units intended to meet Exception No. 2 of 13.1.9 shall be marked inside the terminal compartment where visible after installation and in the Installation Instructions to indicate the hub shall be connected to the conduit before the hub is connected to the enclosure. The letters of the marking shall be not less than 1/16 inch (1.6 mm) high.

53.27 When conduit hubs are not provided on a unit intended for outdoor use, the terminal compartment shall be provided with a marking visible after installation indicating hubs suitable for wet locations that comply with the requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B, are to be used. The letters of the marking shall be not less than 1/16 inch (1.6 mm) high

54 Permanence

54.1 General

54.1.1 The nameplate on a unit shall be of material that is resistant to corrosion and shall be attached by means other than adhesive.

Exception: An adhesive means for attaching a nameplate shall be used if investigated and determined to provide the required permanence. The determination of permanence shall be in accordance with the applicable tests specified in the Standard for Marking and Labeling Systems, UL 969.

54.2 Cord tags

54.2.1 A tag used for the cautionary markings described in 53.21 and 53.23 shall comply with the requirements in 54.2.2 – 54.2.5, and for permanence and legibility in the Standard for Marking and Labeling Systems, UL 969.

54.2.2 Three as-received samples and six samples of the tag that have been subjected to the conditioning specified in 54.2.4, three for each conditioning, are to be subjected to the test described in 54.2.5. After testing, the samples shall comply with the following requirements:

a) The tag shall not tear for more than 1/16 inch (1.6 mm) at any point;

b) The tag shall not separate from the power-supply cord;

c) The tag shall not slip or move along the length of the power-supply cord more than 1/2 inch (12.7 mm);

d) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and

e) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

54.2.3 Each sample is to consist of a length of power-supply cord. The tag is to be affixed to the power supply cord in the required manner. If tags are applied by an adhesive, tests are to be conducted no sooner than 24 hours after application of the tag.

54.2.4 The conditioning required by 54.2.2 is to consist of the following:

a) The samples are to be conditioned for 24 hours in an air-circulating oven maintained at a uniform temperature of 87.0 ±1.0°C (188.6 ±1.8°F). Following removal from the oven, the samples are to remain at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and a relative humidity of 50 ±5 percent for 30 minutes before testing.

b) The samples are to be conditioned for 72 hours in a humidity of 85 ±5 percent at 32.0 ±2.0°C (89.6 ±3.6°F). The samples are to be tested within 1 minute after the conditioning.

54.2.5 The power-supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 pounds (22.3 N) is to be applied to the uppermost corner of the tag farthest from the power-supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord and maintained for 1 minute. In determining compliance with 54.2.2(d), manipulation is possible such as straightening of the tag by hand.

INSTRUCTIONS

55 General

55.1 An instruction manual or the equivalent shall be provided with each unit. The manual shall specifically warn the user of the potential risk of fire, electric shock, or injury to persons and state the precautions that should be taken to reduce such risks. The instruction manual shall include installation instructions that specify information on intended wiring and connection to the supply circuit. The important safety instructions shall be a permanent part of the manual but separate in format from other instructions that are provided and shall appear before the operating instructions in the manual.

55.2 The height of the lettering in the text and illustrations of the important safety instructions shall be as follows:

a) Upper case letters shall not be less than 5/64 inch (2.0 mm) high;

b) Lower case letters shall not be less than 1/16 inch (1.6 mm) high; and

c) The phrases "IMPORTANT SAFETY INSTRUCTIONS," "READ AND FOLLOW ALL INSTRUCTIONS," and "SAVE THESE INSTRUCTIONS" shall be in letters not less than 3/16 inch (4.8 mm) high.

55.3 Instructions shall be provided with each permanently-installed unit to indicate that a solid copper bonding conductor not smaller than 8 AWG (8.4 mm^2) shall be connected from the accessible wire connector on the motor to all metal parts of the swimming pool, spa, or hot tub structure and to all electrical equipment, metal conduit, and metal piping within 5 feet (1.5 m) of the inside walls of a swimming pool, spa, or hot tub, when the motor is installed within 5 feet of the inside walls of the swimming pool, spa, or hot tub. Instructions provided with double insulated units shall indicate the unit is not intended to be bonded to the equipotential bonding grid.

55.4 Instructions shall be provided with each portable unit that is to be field mounted to a base to indicate the intended mounting method. The instructions shall include the wording specified in 53.17.

55.5 Unless otherwise indicated, the instructions shall be in the exact words specified or shall be in equally definitive terminology to the following items. No substitutes shall be used for the words "WARNING" and "CAUTION." The items may be numbered. The first and last items specified below shall be first and last respectively. Other important and precautionary items determined appropriate by the manufacturer may be inserted. Notes to the manufacturer are in parentheses.

IMPORTANT SAFETY INSTRUCTIONS

When installing and using this electrical equipment, basic safety precautions should always be followed, including the following:

1) READ AND FOLLOW ALL INSTRUCTIONS

2) (For all units) WARNING – To reduce the risk of injury, do not permit children to use this product unless they are closely supervised at all times.

3) (For storable pool pumps) WARNING – Risk of Electric Shock. Connect only to a grounding type receptacle. This product is provided with a ground-fault circuit-interrupter. If replacement of the plug or cord is needed, use only identical replacement parts.

4) (For all permanently-installed units intended for use on 15 or 20 ampere, 125 through 240 volt, single phase branch circuits) WARNING – Risk of Electric Shock. Connect only to a branch circuit protected by a ground-fault circuit-interrupter (GFCI). Contact a qualified electrician if you cannot verify that the circuit is protected by a GFCI.

5) (For all permanently installed units intended for use on 15 or 20 ampere, 125 through 240 volt, single phase branch circuits) The unit must be connected only to a supply circuit that is protected by a ground-fault circuit-interrupter (GFCI). Such a GFCI should be provided by the installer and should be tested on a routine basis. To test the GFCI, push the test button. The GFCI should interrupt power. Push the reset button. Power should be restored. If the GFCI fails to operate in this manner, the GFCI is defective. If the GFCI interrupts power to the pump without the test button being pushed, a ground current is flowing, indicating the possibility of an electric shock. Do not use this pump. Disconnect the pump and have the problem corrected by a qualified service representative before using.

6) (For storable pool pumps) The unit is provided with a ground-fault circuit-interrupter (GFCI). To test the GFCI push the test button. The GFCI should interrupt power. Push the reset button. Power should be restored. If the GFCI fails to operate in this manner, the GFCI is defective. If the GFCI interrupts power to the pump without the test button being pushed, a ground current is flowing, indicating the possibility of an electric shock. Do not use this pump. Disconnect the pump and have the problem corrected by a qualified service representative before using.

7) (For storable pool pumps) CAUTION – To reduce the risk of electric shock the pool must be installed no closer than 6 feet (1.8 m) from any electrical outlet. Do not place portable appliances closer than 5 feet (1.5 m) from the pool.

8) (For units intended for above-ground storable swimming pools) Do not bury cord. Locate cord to minimize abuse from lawn mowers, hedge trimmers, and other equipment.

9) (For all cord- and plug-connected units) WARNING – To reduce the risk of electric shock, replace damaged cord immediately.

10) (For units intended for above-ground storable swimming pools) WARNING – To reduce the risk of electric shock, do not use extension cord to connect unit to electric supply; provide a properly located outlet.

11) (For units intended for above-ground storable swimming pools) CAUTION – This pump is for use with storable pools only. Do not use with permanently-installed pools. A storable pool is constructed so that it is capable of being readily disassembled for storage and reassembled to its original integrity. A permanently-installed pool is constructed in or on the ground or in a building such that it cannot be readily disassembled for storage.

12) (For swimming pool pumps intended for use with permanent swimming pools or spas) CAUTION – This pump is for use with permanently-installed pools and may also be used with hot tubs and spas if so marked. Do not use with storable pools. A permanently-installed pool is constructed in or on the ground or in a building such that it cannot be readily disassembled for storage. A storable pool is constructed so that it is capable of being readily disassembled for storage and reassembled to its original integrity.

13) (For hot tub and spa pumps) Do not install within an outer enclosure or beneath the skirt of a hot tub or spa.

14) SAVE THESE INSTRUCTIONS.

PART 2 – ELECTRIC SWIMMING POOL CLEANERS

INTRODUCTION

56 Scope

56.1 These requirements cover electric motor-driven cleaners intended for the cleaning of swimming pools and architectural fountains. The cleaners are self-propelled with motor(s) provided for the suction of debris as well as a means of locomotion. They are cable connected to an isolated transformer or power supply suitable for circuits immersed in bodies of water with swimmers. They are intended to be used when swimmers are not in the body of water. They are intended for use by adult operators who are aware of the possible risks involved with such a product.

57 General

57.1 The requirements in Sections 57 – 75 supplement, and in some cases, modify, the applicable requirements in Part 1 of this standard as they relate to electric swimming pool cleaners.

CONSTRUCTION

58 Cleaner Enclosure

58.1 A polymeric material used to form part of the cleaner enclosure that encloses electrical parts, is exposed to sunlight in normal use, and may be subject to direct impact from outside the cleaner enclosure shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, amended as specified in (a) – (d) below:

a) The requirements for portable attended household equipment shall be considered applicable.

b) UV resistance shall be required.

c) Ball impact for floor-supported appliances shall be used.

d) Cold impact shall reflect storage in unheated warehouses or garages.