UL 778

STANDARD FOR SAFETY

Motor-Operated Water Pumps

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

Sixth Edition, Dated July 7, 2016

Summary of Topics

This revision of ANSI/UL 778 dated June 29, 2021 includes the following changes in requirements:

– Addition of reference to UL 969A for cord tags; 54.6 – 54.14

– Editorial corrections; 40.1.2

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 May 21, 2021.

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Standard for Motor-Operated Water Pumps

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The most recent designation of ANSI/UL 778 as an American National Standard (ANSI) occurred on June 29, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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

No Text on This Page

CONTENTS

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

INTRODUCTION

CONSTRUCTION

PROTECTION AGAINST INJURY TO PERSONS

PERFORMANCE

MANUFACTURING AND PRODUCTION-LINE TESTS

SUPPLEMENT SA – SUPPLEMENTAL REQUIREMENTS FOR PUMPS INTENDED FOR INSTALLATION IN ENVIRONMENTAL AIR HANDLING SPACES (Plenums)

SUPPLEMENT SB – UL 60335-1 BASED REQUIREMENTS FOR THE EVALUATION OF ELECTRONIC CIRCUITS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

MANUFACTURING AND PRODUCTION LINE TESTS

SUPPLEMENT SC – SECONDARY CIRCUITS EVALUATED TO NEC CLASS 2 DERIVED REQUIREMENTS

CONSTRUCTION

PERFORMANCE

No Text on This Page

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

INTRODUCTION

1 Scope

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

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

1.3 A pump not covered by any of the definitions in Definitions, Section 4, and a pump intended for use with liquids other than water, shall be evaluated on the basis of its compliance with the requirements in this standard, and further examination and tests required to determine whether it is acceptable for the purpose. This would include but not be limited to pumps intended for water/glycol and similar mixtures intended for use in hot water radiant heating or thermal solar applications.

2 Units of Measurement

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

2.2 Unless otherwise indicated, 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 Definitions

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

4.2 CAPACITOR, CLASS X – Capacitor or RC unit of a type suitable for use in situations where failure of the capacitor or RC unit would not lead to danger of electrical shock but could result in a risk of fire. Examples would be units connected phase to phase or phase to neutral.

4.3 CAPACITOR, CLASS Y – Capacitor or RC unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock. Examples would be capacitors connected across the primary and secondary circuits where electrical isolation is required to prevent an electric shock or between hazardous live parts and accessible parts.

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

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

4.6 DANGEROUS MALFUNCTION – Unintended operation of the appliance that may impair safety. Operating Control functions whose failure would result in a Dangerous Malfunction would be considered Safety Critical Functions.

Control functions whose failure might result in a Dangerous Malfunction would include:

a) Unexpected operation of the appliance where the operation would result in risk of electric shock, fire or mechanical hazard.

b) Unattended energization of a heating appliance where the user has placed flammable materials near the appliance based on the assumption the appliance would remain off.

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

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

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

4.10 ENCLOSURE, ELECTRICAL – That part of the product that renders inaccessible all or any parts of the equipment that may otherwise present a risk of electric shock.

4.11 ENCLOSURE, FIRE – That part of the product that retards propagation of flame initiated by electrical disturbances occurring within.

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

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

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

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

4.16 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of no more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.

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

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

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

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

4.21 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a hazardous situation under abnormal operating conditions. The function of a Protective Electronic Circuit would be considered a Safety Critical Function.

4.22 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist within a circuit unless the circuit meets one of the following criteria, both under normal conditions and under single component fault conditions. See Component Breakdown Test, 48.3. The circuit shall be supplied by an isolating source such that:

a) The voltage does not exceed 30 V rms;

b) The voltage does not exceed 42.4 V peak;

c) The voltage does not exceed 60 V dc continuous; or

d) The voltage does not exceed 24.8 V peak for DC interrupted at a rate of 200 Hz or less with approximately 50 percent duty cycle.

e) When protective impedance is used, the current available through a 1500 ohm resistor between the part or parts and either pole of the supply source does not exceed 0.7 mA peak or 2 mA DC;

1. For frequencies exceeding 1 kHz, the limit of 0.7 mA (peak value) is multiplied by the value of the frequency in kHz but shall not exceed 70 mA peak;

2. For voltages over 42.4 V peak and up to and including 450 V (peak value) the capacitance shall not exceed 0.1 µF.

4.23 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit, both under normal conditions and under single component fault conditions, where a power of more than 15 watts can be delivered into an external resistor connected between the two points.

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

4.25 SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means). A secondary circuit that has a direct connection back to the primary circuit is considered part of the primary circuit.

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

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

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

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

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

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

4.32 VOLTAGE FOLDBACK – A circuit design feature intended to protect the power supply output transistors. When overcurrent is drawn by the load, the supply reduces the output voltage and current to within the safe power dissipation limit of the output transistors.

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

4.34 WORKING VOLTAGE – The highest voltage to which the insulation or the component under consideration is, or can be, subjected when the equipment is operating under conditions of normal use. Overvoltages that originate outside the equipment are not taken into account.

5 Instructions Provided With the Pump

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

6 Safety Critical Functions

6.1 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.

6.2 Electronic circuits that manage a Safety Critical Function (SCF) shall be:

a) Reliable as defined as being able to maintain the SCF in the event of single defined component faults and

b) Not susceptible to electromagnetic environmental stresses encountered in the anticipated environments of the appliance.

6.3 Electronic circuits managing Safety Critical Functions shall comply with:

a) UL 60335-1 Based Requirements for the Evaluation of Electronic Circuits, Supplement SB or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and it's Part 2's 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) or

c) The requirements for the component as noted elsewhere in this standard.

6.4 Functions specified in Safety critical functions, Table 6.1 represent the common safety critical circuit functions of pumps. It is not intended to represent all possible safety critical functions.

Table 6.1
Safety critical functions

Function (see)	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	25.2
Motor locked rotor protection	Risk of fire or electric shock	25.2
Motor short circuit protection	Risk of fire or electric shock	25.2
Dry operation	Risk of fire or electric shock	53.1
Burnout test	Risk of fire or electric shock	53.2
Transformation overload	Risk of fire or electric shock	53.5
Switch Mode Power Supply Overload	Risk of fire or electric shock	53.6
Loss of phase	Risk of fire	25.2

CONSTRUCTION

7 General

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

7.2 A pump shall be acceptable for both indoor and outdoor use unless marked as specified in 58.6.

8 Component Specifications

8.1 Components

8.1.1 Except as indicated in 8.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

8.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

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

8.1.4 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.

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

a) Pollution Degree III installations.

b) Overvoltage Category II.

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

8.2 Fuses

8.2.1 Fuses specified in 29.5 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.

8.3 Fuseholders

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

a) The Standard for Fuseholders – Part 4: Class CC, UL 4248-4; or

b) The Standard for Fuseholders – Part 5: Class G, UL 4248-5; or

c) The Standard for Fuseholders – Part 6: Class H, UL 4248-6; or

d) The Standard for Fuseholders – Part 8: Class J, UL 4248-8; or

e) The Standard for Fuseholders – Part 9: Class K, UL 4248-9; or

f) The Standard for Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse, UL 4248-11; or

g) The Standard for Fuseholders – Part 12: Class R, UL 4248-12; or

h) The Standard for Fuseholders – Part 15: Class T, UL 4248-15.

8.4 Printed wiring boards

8.4.1 Printed wiring boards shall comply with the Standard for Printed-Wiring Boards, UL 796. A printed wiring board shall have a temperature rating corresponding to the maximum temperature on the board during the Temperature Test, Section 40. It shall comply with the direct support of live parts requirements in UL 796. For printed-wiring boards in secondary control circuits, see Secondary Circuits, Section SC1.

8.5 Quick-connect wire connectors

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

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

8.6 Terminal blocks

8.6.1 Terminal blocks shall comply with:

a) The Standard for Terminal Blocks, UL 1059; or

b) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-1: Ancillary Equipment – Terminal Blocks for Copper Conductors, UL 60947-7-1; or

c) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-2: Ancillary Equipment – Protective Conductor Terminal Blocks for Copper Conductors, UL 60947-7-2; or

d) The Standard for Low-Voltage Switchgear And Controlgear – Part 7-3: Ancillary Equipment – Safety Requirements for Fuse Terminal Blocks, UL 60947-7-3.

8.6.2 The UL 60947-7 Series Standards specified in 8.6.1 (b) – (d) are used in conjunction with the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1.

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

8.7 Wire connectors

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

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

8.8 Isolation devices

8.8.1 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this Standard shall be constructed in accordance with the Standard for Optical Isolators, UL 1577, and shall be able to withstand for 1 minute, without breakdown, an ac dielectric voltage withstand potential specified in 41.1 equal to between the input and output circuits.

Exception No. 1: An optical isolator need not be subjected to the requirements in UL 1577 if the internal insulation is of such a material and at such a thickness that it complies with 41.1.

Exception No. 2: An optical isolator that is constructed in accordance with the requirements in UL 1577, but at a dielectric potential less than 1000 V plus twice rated voltage ac is considered to comply with 41.1 if the internal insulation is at such thickness that it also complies with 21.1(c).

8.8.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall be constructed in accordance with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted at a dielectric potential specified in 41.1 for 1 minute.

Exception No. 1: A power switching semiconductor need not be subjected to the requirements in UL 1557 if the internal insulation is of such material and at such a thickness that it complies with 41.1.

Exception No. 2: A power switching semiconductor that is constructed in accordance with the requirements in UL 1557 but at a dielectric potential less than 1000 V plus twice rated voltage ac is considered to comply with 41.1 if the internal insulation is at such thickness that it also complies with 21.1(c).

8.8.3 A power switching semiconductor device that is relied upon to provide isolation between primary and secondary circuits or between other circuits shall be a device (such as a solid state motor controller) that complies with the Standard for Industrial Control Equipment, UL 508.

Exception: A power switching semiconductor device located within a component that has been separately evaluated to the requirements for that component is not required to be further evaluated, provided the component is used within its established ratings and limitations.

8.8.4 A relay that is relied upon to provide isolation between primary and secondary circuits shall comply with either the Standard for Industrial Control Equipment, UL 508 or the Standard for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1.

8.8.5 A transformer relied upon to provide isolation between primary and secondary circuits shall comply with requirements specified in Table SC1.2.

8.9 Switch mode power supply insulation system – Triple-insulated magnet wire

8.9.1 Insulation used within a transformer of switch mode power supply shall comply with the Standard for Systems of Insulating Materials – General, UL 1446, for the specified temperature class of the insulation system or the Standard for Single- and Multi-Layer Insulated Winding Wire, UL 2353.

9 Adhesives Used to Secure Parts

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

9.2 The requirement in 9.1 also applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

a) Energize an accessible dead metal part,

b) Make a live part accessible,

c) Reduce spacings below the minimum acceptable values, or

d) Short-circuit live parts.

10 Electrical and Fire Enclosures

10.1 General

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

10.1.2 When evaluating a pump in accordance with Section 10, Electrical and Fire Enclosures, circuits that do not involve a risk of electric shock are:

a) A Class 2 or LPS circuit of SC1.3.1;

b) A Limited Voltage circuit of SC1.3.2;

c) A SELV circuit of SC1.3.6;

d) A Limited Voltage/Limited Energy circuit of SC1.3.4; and

e) A Protective Impedance circuit of SC1.3.5.1 that additionally complies with SC1.3.5.3.

10.1.3 For the purpose of this Standard, the secondary circuits that do not involve a risk of fire are:

a) A Protective Impedance circuit of SC1.3.5

b) Other isolated secondary circuits that limit the maximum available output power to 15 watts or less.

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

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

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

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

10.1.8 An enclosure of sheet metal shall be evaluated with regard to its size, shape, thickness of metal, and acceptability for the application. Uncoated sheet steel less than 0.026 inch (0.6 mm) thick, galvanized sheet steel less than 0.029 inch (0.74 mm) thick, sheet aluminum less than 0.036 inch (0.91 mm) thick,

and sheet copper or sheet brass less than 0.033 inch (0.84 mm) thick shall not be used other than in relatively small areas or for surfaces that are curved, ribbed, or otherwise reinforced.

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

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

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

a) Mechanical strength and rigidity;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability;

e) Resistance to distortion at temperatures to which the material may be subjected under conditions of actual use; and

f) Resistance to ignition.

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

a) Material Properties – The material shall comply with the “Material property considerations” table in UL 746C.

b) Impact Test – A minimum impact of 5 ft-lbf (6.8 J) shall apply to all enclosure materials. In addition to the test requirements specified in UL 746C, any cracking of a polymeric material that would be exposed to water is considered unacceptable. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.

c) Abnormal Operations – See the Abnormal Operation Test, Section 53.

d) Mold-Stress Relief Distortion – In addition to the test requirements specified in UL 746C, any cracking of a polymeric material that is exposed to water is considered unacceptable. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.

e) Strain Relief – This test is only required when the strain-relief means is secured to the enclosure or is an integral part of the polymeric enclosure.

f) UV Resistance – This test is only required when the equipment is intended for outdoor use. All other parts constructed of materials that do not comply with the enclosure requirements shall be removed during this test.

g) Flammability – Minimum flammability rating of polymeric enclosures shall be 5VA, 5VB, V-0, V-1, V-2 for portable pumps and 5VA for all other types of pumps.

h) Water Exposure and Immersion – Polymeric materials shall comply with UL 746C.

i) Dimensional Stability – Polymeric materials shall comply with UL 746C.

j) Conduit Connections – Products permanently connected electrically shall comply with the requirements in UL 746C.

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

10.1.14 The requirement in 10.1.13 necessitates the use of a barrier or pan of nonflammable material under a motor unless:

a) The structural parts of the pump or motor provide the equivalent of such a barrier;

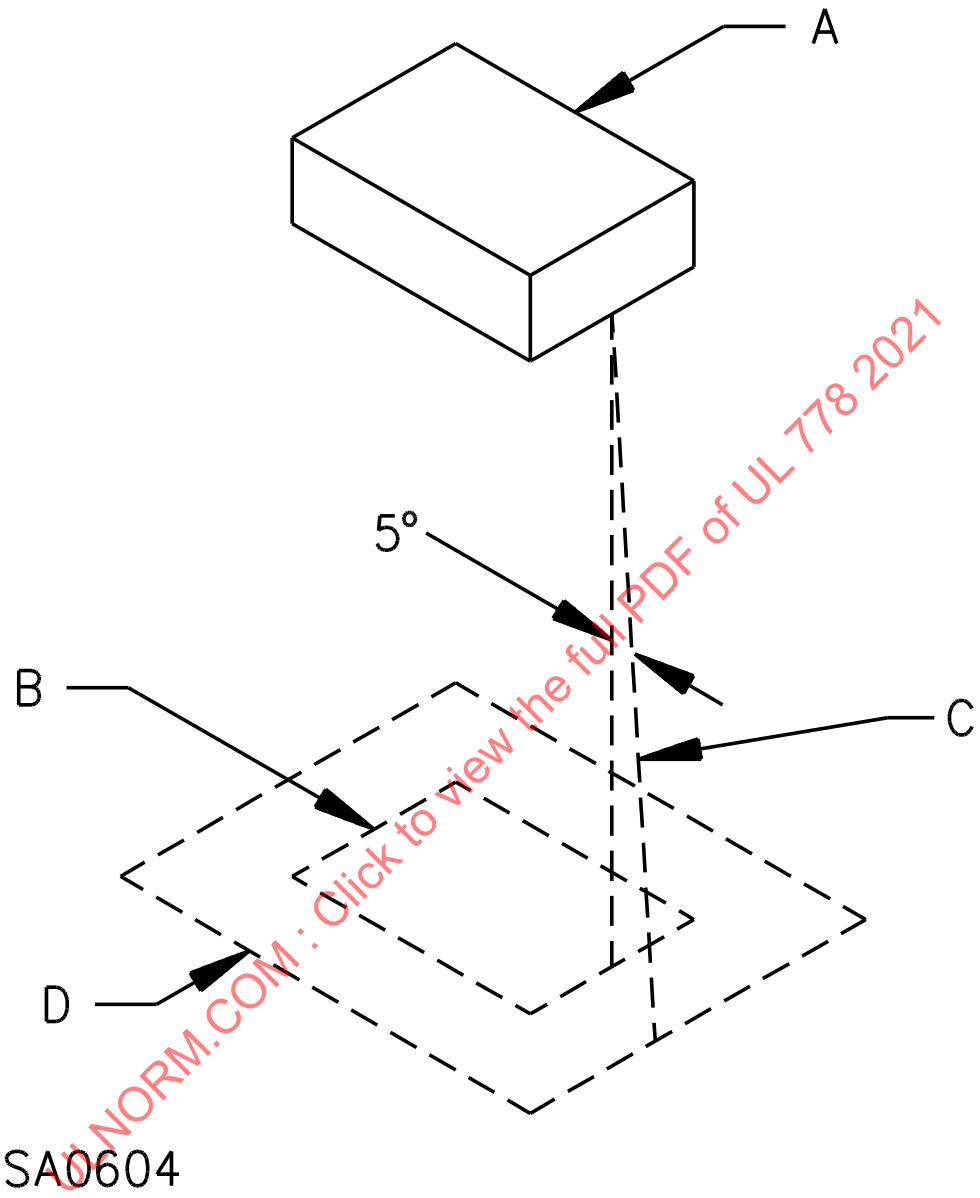
b) The overload protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the pump when the motor is energized under open main winding, open start winding, starting-switch short circuit, or split-phase motor capacitor short-circuit conditions; or

c) The motor complies with the requirements for impedance-protected motors in the Standard for Overheating Protection for Motors, UL 2111, and is rated for the application.

10.1.15 The barrier required in 10.1.14 shall be horizontal or constructed to provide equivalent protection, located as illustrated in Figure 10.1, and shall be not smaller in area than indicated in that figure. Openings for drainage, ventilation, and the like, may be used in the barrier when they are protected by a baffle, a screen, or the like, so that molten metal, burning insulation, and the like, cannot fall outside the enclosure.

Figure 10.1

Location and extent of barrier



A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded, and will consist of the unshielded portion of a component which is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line which traces out minimum area of barrier. When moving, the line is always:

1) Tangent to the component,

2) 5 degrees from the vertical, and

3) Oriented so that the area traced out on a horizontal plane is maximum.

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

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

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

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

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

10.2 Enclosures of secondary circuits

10.2.1 Electrical enclosures

10.2.1.1 If the secondary circuit presents a risk of electric shock, it shall be enclosed per Electrical and Fire Enclosures, Section 10.

10.2.2 Fire enclosures

10.2.2.1 If the secondary circuit presents a risk of fire, it shall be provided with a Fire Enclosure. An enclosure complying with Electrical and Fire Enclosures, Section 10 is considered to meet this requirement.

11 Parts in Contact with Potable Water

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

12 Provision for Servicing

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

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

13 Mechanical Assembly

13.1 A pump shall be assembled so that it will not be adversely affected by the vibration of normal operation. See Polymeric Motor Supports, Section 33.

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

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