



UL 778

STANDARD FOR SAFETY

Motor-Operated Water Pumps

ULNORM.COM : Click to view the full PDF of UL 778 2021

ULNORM.COM : Click to view the full PDF of UL 778 2021

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.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 778 2021

JULY 7, 2016
(Title Page Reprinted: June 29, 2021)



ANSI/UL 778-2021

1

UL 778

Standard for Motor-Operated Water Pumps

First Edition – October, 1980
Second Edition – October, 1991
Third Edition – April, 1996
Fourth Edition – December, 2002
Fifth Edition – February, 2010

Sixth Edition

July 7, 2016

This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through June 29, 2021.

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>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

COPYRIGHT © 2021 UNDERWRITERS LABORATORIES INC.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 778 2021

CONTENTS

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

INTRODUCTION

1	Scope	9
2	Units of Measurement	9
3	Undated References	9
4	Definitions	9
5	Instructions Provided With the Pump	12
6	Safety Critical Functions	12

CONSTRUCTION

7	General	13
8	Component Specifications	13
8.1	Components	13
8.2	Fuses	14
8.3	Fuseholders	14
8.4	Printed wiring boards	15
8.5	Quick-connect wire connectors	15
8.6	Terminal blocks	15
8.7	Wire connectors	15
8.8	Isolation devices	15
8.9	Switch mode power supply insulation system – Triple-insulated magnet wire	16
9	Adhesives Used to Secure Parts	16
10	Electrical and Fire Enclosures	17
10.1	General	17
10.2	Enclosures of secondary circuits	21
11	Parts in Contact with Potable Water	21
12	Provision for Servicing	21
13	Mechanical Assembly	21
14	Protection Against Corrosion	22
15	Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts	25
16	Supply Connections	31
16.1	General	31
16.2	Terminal compartments	33
16.3	Field wiring terminals and leads	36
16.4	Identified terminals and leads	37
16.5	Strain relief	37
16.6	Bushings	37
16.7	Contractor pumps	37
16.8	Deep-well submersible pumps	38
16.9	Sump pumps and portable pumps	38
16.10	Cord-connected pumps	38
16.11	Fountain pumps	40
16.12	Elevator hoistway sump pumps	40
17	Current-Carrying or Live Parts	40
18	Insulating Material	40
19	Internal Wiring	41
19.1	Mechanical protection	41
19.2	Splices and connections	42
20	Spacings	42

20.1	At field-wiring terminals	42
20.2	In a motor.....	43
20.3	Spacings other than in a motor or at field-wiring terminals	43
21	Insulating Barriers	44
22	Clearance and Creepage Distances.....	45
23	Separation of Circuits	46
23.1	Separation between different internal wiring circuits (factory-installed conductors)	46
23.2	Separation between different field wiring circuits (field-installed conductors).....	46
23.3	Separation between field wiring circuits (field-installed conductors) and internal wiring circuits (factory-installed conductors)	47
23.4	Segregation methods	47
23.5	Separation methods.....	48
24	Grounding	48
24.1	General.....	48
24.2	Bonding	49
24.3	Grounding identification	51
24.4	Double insulation	51
25	Motors.....	52
25.1	Construction.....	52
25.2	Overload protection	53
26	Overload-Protective Devices	54
27	Capacitors	55
28	Switches and Controls	56
29	Line Voltage Submersible Pumps with Submersible Luminaires	57

PROTECTION AGAINST INJURY TO PERSONS

30	Sharp Edges	58
31	Materials.....	59
32	Stability	59
33	Polymeric Motor Supports.....	59
34	Parts Subject to Pressure.....	60
35	Pressure-Relief Devices	61
35A	Button or Coin Cell Batteries of Lithium Technologies	62

PERFORMANCE

36	Leakage Current Test	62
37	Leakage Current Test Following Humidity Conditioning	63
38	Starting Current Test.....	63
39	Input Test.....	63
40	Temperature Test	64
40.1	General.....	64
40.2	Maximum normal load	68
41	Dielectric Voltage-Withstand Test	69
41.1	General.....	69
41.2	Secondary circuits	70
42	Oil Dielectric Voltage-Withstand Test.....	71
43	Resistance to Moisture Test	71
44	Submersion Test	74
45	Flooding Test	74
46	Insulation Resistance Test	75
47	Test for Deterioration of Parts Subject to Flexing.....	75
48	Test for Reliability of Parts Not Subject to Flexing.....	76
49	Metallic Coating Thickness Test.....	79
50	Switches and Controls Test	80

51	Strain Relief Tests	82
52	Operation Test	82
53	Abnormal Operation Test	82
53.1	Dry operation.....	82
53.2	Burnout test.....	83
53.3	Component breakdown test.....	83
53.4	Low-voltage luminaire dry operation test.....	84
53.5	Transformer overload test.....	85
53.6	Switch mode power supply overload test	85
53.7	Secondary circuits tests	86
54	Permanence of Markings	88

MANUFACTURING AND PRODUCTION-LINE TESTS

55	Dielectric Voltage-Withstand Test	90
56	Grounding Continuity Test.....	91

RATINGS

57	Details.....	91
----	--------------	----

MARKINGS

58	Details	92
59	Cautionary	95

INSTRUCTION MANUAL

60	General	96
61	Installation and Operating Instructions	96
62	Grounding Instructions.....	97

PART 2 – PORTABLE FOUNTAIN PUMPS POWERED BY SEPARATE CLASS 2 SOURCES

CONSTRUCTION

63	General	98
64	Power Supply.....	98
65	Low-Voltage Luminaires.....	99

PERFORMANCE

66	Input.....	99
----	------------	----

RATING

67	General	99
----	---------------	----

MARKINGS

68	General	100
----	---------------	-----

MANUFACTURING AND PRODUCTION-LINE TESTS

69	General	100
----	---------------	-----

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

SA1	Scope	101
SA2	Construction	101
SA3	Markings	101
SA4	Installation and Operating Instructions	101

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

INTRODUCTION

SB1	Scope	103
SB2	General	103
SB3	Glossary	103

CONSTRUCTION

SB4	Components	104
SB4.1	Capacitors	104
SB4.2	Isolation devices	104
SB4.3	Printed wiring boards	104
SB4.4	Temperature sensing, thermistor devices	105
SB4.5	Transformers	105
SB5	Identification of Safety Critical Circuit Functions	105
SB5.1	General	105
SB5.2	Protective electronic circuits	105
SB5.3	Operating circuits that mitigate a dangerous malfunction of the appliance	105
SB6	Evaluation of the Different Types of Electronic Circuits – All Types of Circuits	106
SB7	Circuits That Provide Safety Critical Functions	106

PERFORMANCE

SB8	General Conditions for the Tests	106
SB8.1	Details	106
SB8.2	Intentionally weak parts	107
SB8.3	Test results determined by overcurrent protection operation	107
SB9	Low-Power Circuits	108
SB9.1	Low-power circuit determination	108
SB10	Abnormal Operation and Fault Tests	108
SB11	Programmable Component Reduced Supply Voltage Test	110
SB12	Electromagnetic Compatibility (EMC) Requirements – Immunity	110

MANUFACTURING AND PRODUCTION LINE TESTS

SB13	General	111
------	---------------	-----

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

CONSTRUCTION

SC1	Secondary Circuits	113
SC1.1	Components.....	113
SC1.2	General.....	114
SC1.3	Evaluation of the different types of secondary circuits	116

PERFORMANCE

SC2	Component Breakdown Test.....	119
SC3	Secondary Circuits Tests.....	120
SC3.1	General.....	120
SC3.2	Limited energy secondary test	120
SC3.3	Limited voltage secondary test.....	120
SC3.4	Protective impedance test	121
SC3.5	Printed wiring board abnormal operation test.....	121

ULNORM.COM : Click to view the full PDF of UL 778 2021

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 778 2021

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 μ F.

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 its 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.

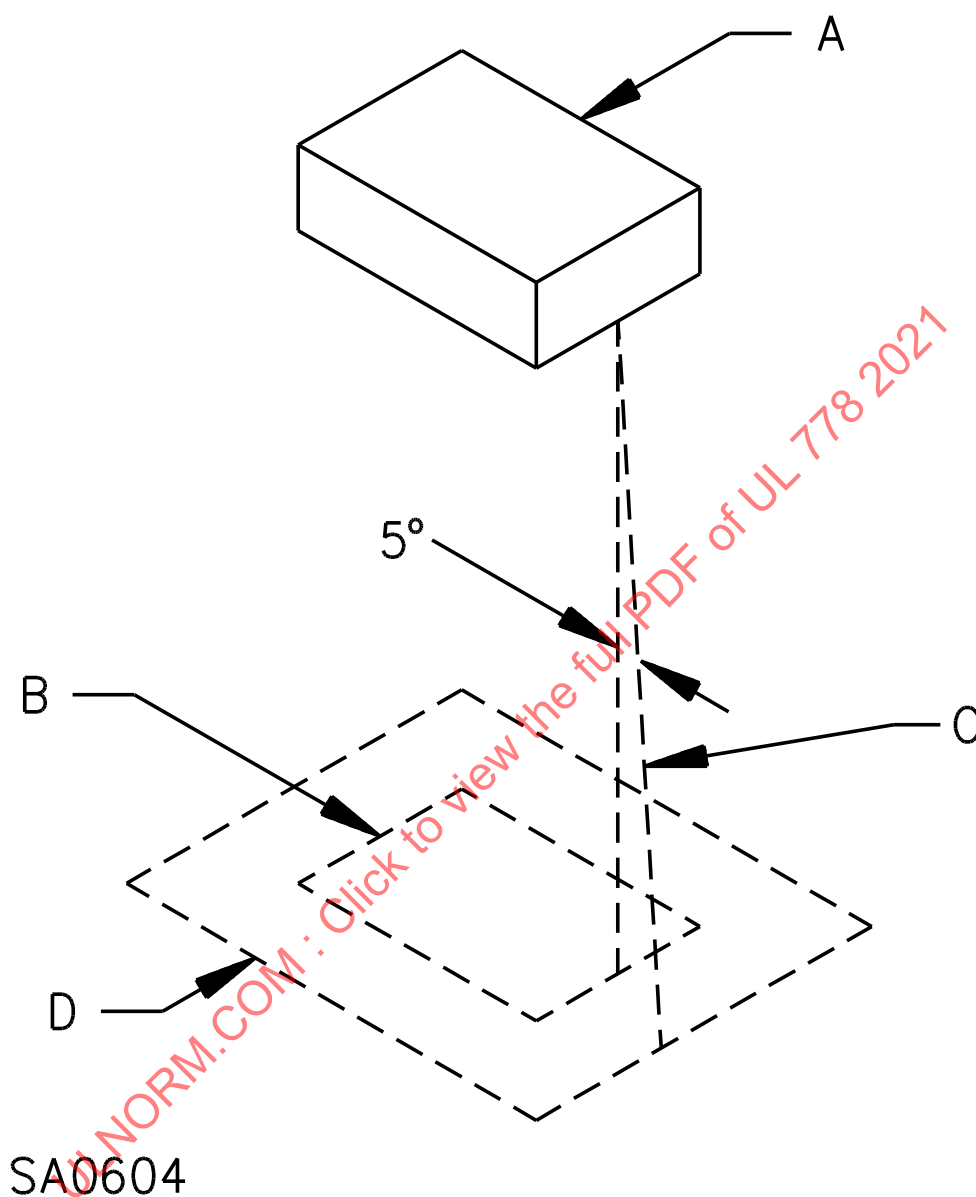
10.1.14 The requirement in [10.1.13](#) necessitates the use of a barrier or pan of nonflammable material under a motor unless:

- 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.

ULNORM.COM : Click to view the full PDF of UL 778 2021

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:

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

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

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

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

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

14 Protection Against Corrosion

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

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

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

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

14.2 A sheet-steel cabinet or an electrical enclosure intended for outdoor use shall be protected against corrosion by the means specified in [Table 14.1](#) or by other metallic or nonmetallic coatings that have been shown to provide equivalent resistance.

Exception: As specified in Exception Nos. 1 – 3 to [14.1](#).

Table 14.1
Paragraphs for judging protection against corrosion

Type of cabinet or enclosure	Minimum thickness of steel	
	0.056 inch (1.42 mm) and thicker	Less than 0.056 inch (1.42 mm) thick
Outer cabinet that protects a motor, wiring, or encloses current-carrying parts	14.3	14.4
Inside enclosure that protects current-carrying parts other than a motor	14.3	14.4
Outer cabinet that is the sole enclosure of current-carrying parts	14.4	14.4

14.3 With reference to [Table 14.1](#), as applicable, one of the following coatings shall be used:

- a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G60 or A60 in Table I of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with no less than 40 percent of the zinc on any one side, based on the minimum single-spot test requirement in this designation. The weight of the coating shall be established in accordance with the test method of ASTM Designation A90-69, or by any method that has been determined to be similar. An A60 (alloyed) coating shall also comply with [14.6](#).
- b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of no less than 0.00041 inch (0.0104 mm) on each surface, with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section [49](#). An annealed coating shall also comply with [14.6](#).
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint is to be determined by consideration of the composition or, when required, by the corrosion tests specified in [14.5](#).
- d) A single coat of an organic finish of the epoxy or alkyd-resin type over phosphate- or oxide-treated steel in a form that has been shown to be equivalent to mill-galvanized steel as noted in (a). Organic coatings shall comply with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

14.4 With reference to [Table 14.1](#), as applicable, one of the following coatings shall be used:

- a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in Table I of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with no less than 40 percent of the zinc on any side, based on the minimum single-spot-test requirement in this designation. The weight of the zinc coating shall be established in accordance with the test method of ASTM Designation A90-69, or by any method that has been determined to be similar.
- b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of no less than 0.00061 inch (0.01549 mm) on each surface with a minimum thickness of 0.00054 inch (0.01372 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section [49](#). An annealed coating shall also comply with [14.6](#).
- c) A cadmium coating no less than 0.001 inch (0.0254 mm) thick on both surfaces. The thickness of the coating shall be established in accordance with the Metallic Coating Thickness Test, Section [49](#).

d) A zinc coating that complies with [14.3](#) (a) or (b), with one coat of outdoor paint as specified in [14.3](#)(c) on each surface.

e) A cadmium coating no less than 0.00075 inch (0.01905 mm) thick on both surfaces, with one coat of outdoor paint on both surfaces, or no less than 0.0005 inch (0.0127 mm) thick on both surfaces, with two coats of outdoor paint on each surface. The thickness of the cadmium coating shall be established in accordance with the Metallic Coating Thickness Test, Section [49](#), and the paint shall be as specified in [14.3](#)(c).

14.5 With reference to [Table 14.1](#) and [Table 14.2](#), other finishes, including paints, metallic finishes, and combinations of the two may be acceptable when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) that are in compliance with [14.3](#)(a) or [14.4](#)(a) indicate that they provide equivalent resistance. Among the factors considered when evaluating the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light, and water. Organic coatings shall comply with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

Table 14.2
Aluminum alloys

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

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

14.7 When flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered to be damaged. Simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes shall comply with the requirement in [14.6](#).

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

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

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

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

14.11 Sheet and plate aluminum normally in contact with water shall be an alloy of the 5000 series as given in the Standard Specification for Aluminum Alloy Sheet and Plate, ASTM B-209 and cast aluminum shall be one of the alloys listed in [Table 14.2](#), or shall be an alloy that has been found to have equivalent resistance to corrosion.

14.12 A part of a vessel supplied for use with a pump that is subjected to pressure, including a rivet, a screw, and a surface in contact with water, shall resist corrosion by means as described in [14.1](#) – [14.8](#).

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

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

- a) Electric shock from an uninsulated live part or film-coated wire or
- b) Injury to a person from a moving part, an opening in an enclosure shall comply with either (1) or (2):
 - 1) For an opening that has a minor dimension (see [15.5](#)) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in [Figure 15.1](#).
 - 2) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in [Table 15.1](#).

Exception: A motor other than one used in either a hand-held pump or a hand-supported portion of a pump is not required to comply with these requirements when it complies with the requirements in [15.2](#).

Table 15.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension ^a of opening,		Minimum distance from opening to part,	
inches	(mm) ^b	inches	(mm) ^b
3/4 ^c	(19.1)	4-1/2	(114.0)
1 ^c	(25.4)	6-1/4	(165.0)
1-1/4	(31.8)	7-1/2	(190.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(444.0)
d		30	(762.0)

^a See [15.5](#).
^b Between 3/4 and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
^c Any dimension less than 1 inch applies only to a motor.
^d More than 2-1/8 inches, but not more than 6 inches (152 mm).

15.2 With regard to a part or wire as mentioned in [15.1](#), in an integral enclosure of a motor as mentioned in the Exception to [15.1](#):

a) An opening that has a minor dimension (see [15.5](#)) less than 3/4 inch (19.1 mm) is acceptable if:

- 1) A moving part or a film-coated wire cannot be contacted by the probe illustrated in [Figure 15.2](#);
- 2) In an indirectly accessible motor (see [15.6](#)), an uninsulated live part cannot be contacted by the probe illustrated in [Figure 15.3](#); and
- 3) In a directly accessible motor (see [15.6](#)), an uninsulated live part cannot be contacted by the probe illustrated in [Figure 15.4](#).

b) An opening that has a minor dimension of 3/4 inch or more is acceptable if a part or wire is spaced from the opening as specified in [Table 15.1](#).

Figure 15.2

Probe for moving parts and film-coated wire

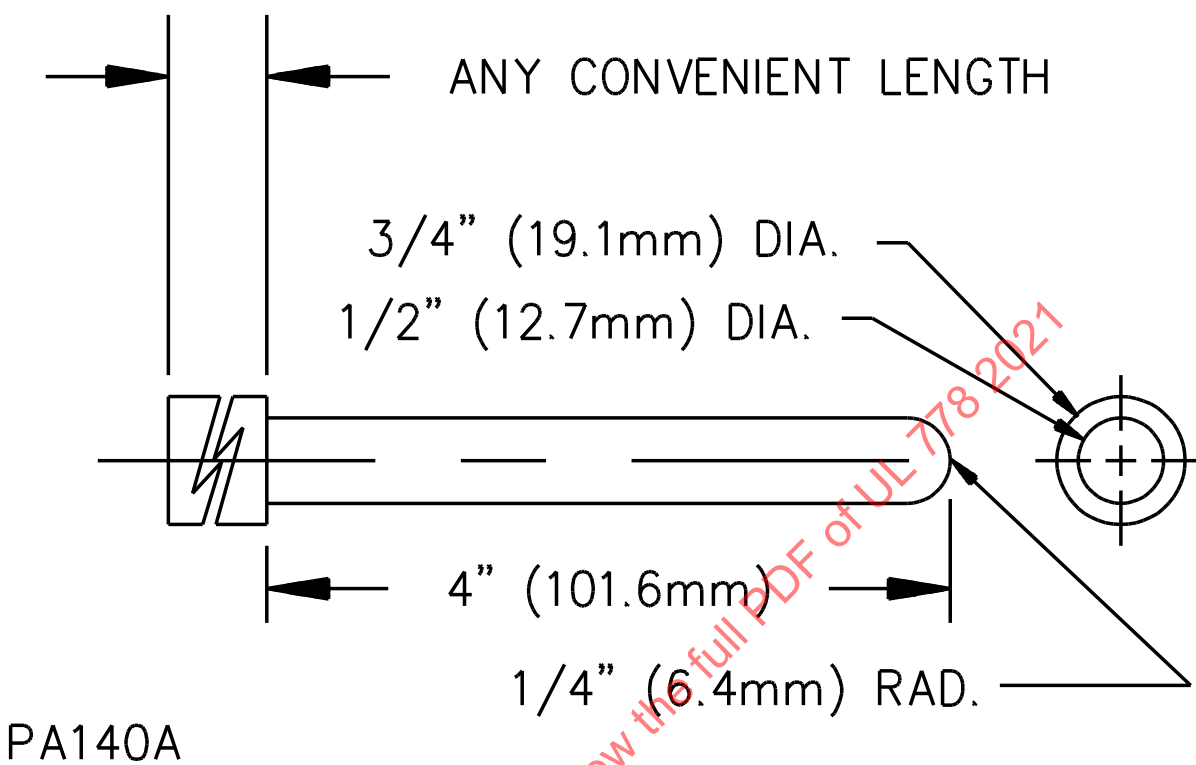


Figure 15.3
Probe for uninsulated live parts

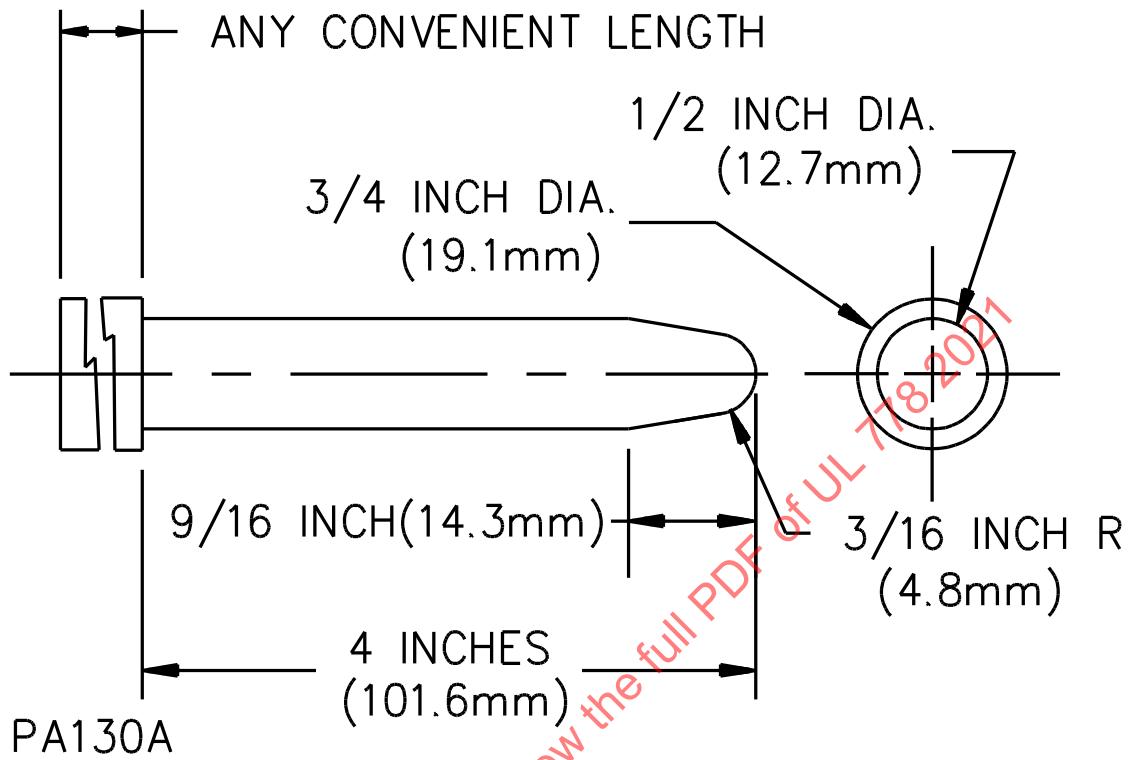
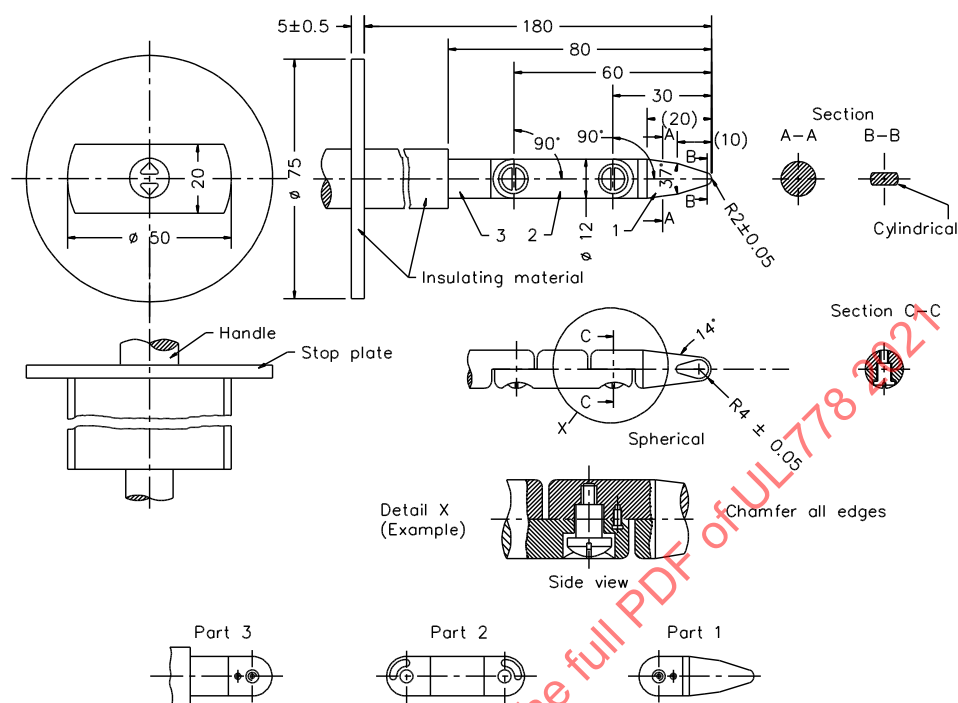


Figure 15.4

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



SA1788A

15.3 The probes specified in 15.1 and 15.2 and illustrated in Figure 15.1 – Figure 15.4 shall be applied to any depth that the opening permits, and shall be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the enclosure. The probes illustrated in Figure 15.1 and Figure 15.4 shall be applied in any possible configuration; and, when required, the configuration shall be changed after insertion through the opening.

15.4 The probes specified in 15.3 and 15.5 shall be used as measuring instruments to evaluate the accessibility provided by an opening, and not as instruments to evaluate the strength of a material; they shall be applied with the minimum force required to determine accessibility.

15.5 With reference to the requirements in 15.1 and 15.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

15.6 With reference to the requirements in 15.2, an indirectly accessible motor is a motor:

- That is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool or
- That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

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

15.7 During the examination of a pump to determine whether it complies with the requirements in [15.1](#) or [15.2](#), a part of the enclosure that may be 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.

Exception: A snap-on cover on the enclosure of a water-level switch or other motor controller used on an indoor pump assembly need not be removed.

15.8 An opening in an impeller housing shall be judged with normal inlet and discharge connections in place. An opening in a pump intended for fixed installation shall be judged with the pump installed as intended.

Exception: An opening in an impeller housing of a pump that is inaccessible to the user during normal operation, such as a sewage pump, is not required to be additionally enclosed.

15.9 With reference to the requirements in [15.1](#) and [15.2](#), insulated brush caps are not required to be additionally enclosed.

16 Supply Connections

16.1 General

16.1.1 Except as noted in [16.1.2](#), [16.7.1](#)–[16.10.9](#), and [16.11.1](#)–[16.11.3](#), a pump shall have provision for permanent connection of one of the wiring systems that have been determined to be appropriate for the type of pump.

Exception: A terminal compartment provided as an integral part of a motor that complies with the requirements for field wiring in 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 [16.1.3](#)–[16.1.10](#) and [16.2.1](#)–[16.2.10](#).

16.1.2 It is permitted for a pump intended for permanent installation to be provided with a permanently installed flexible cord and an attachment plug for supply connection when it complies with (a) or (b):

a) The mounting means and plumbing connections to the plumbing system are such that:

- 1) The pump fastening means are specifically designed to permit ready removal for maintenance and repair.
- 2) The connections to the plumbing system are intended for ease of removal, and that the removal is capable of being accomplished without the need to braze, solder, weld, cut, or otherwise damage the connection.

b) The pump is intended to be supported by its circulation piping and:

- 1) The use of unions during installation is specified in the Installation Instructions or
- 2) The design is such that the motor/impeller securement to the pump housing is intended for ready removal for maintenance or replacement after installation.

Exception: It is permitted for a permanently-installed pump to be provided with a flexible cord intended to be removed in the field and attachment plug when the wiring compartment is constructed in accordance with the requirements in [16.2.1](#)–[16.1.3](#)–[16.1.7](#), [16.1.9](#), [16.1.10](#), and [16.2.1](#)–[16.2.6](#), and the cord is attached in such a manner that it is possible to remove the cord in the field and make a permanent connection to the power supply in accordance with the requirements in [16.3.1](#)–[16.3.9](#), [16.4.1](#), and [16.4.2](#).

16.1.3 There shall be a flat surface surrounding a knockout or conduit opening. The flat surface shall have an area that permits assembly to the appliance of a length of standard rigid metallic conduit. 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 16.1](#).

Table 16.1
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)

16.1.4 A permanently-connected, nonsubmersible pump intended for installation outdoors shall have:

- a) 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 [16.1.8](#).

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 [58.26](#).

16.1.5 When a hole in an enclosure wall is tapped all the way through for connection of conduit, or when an equivalent construction is used, there shall not be fewer than 3-1/2 or more than five threads in the metal, and it shall be constructed so that a conduit bushing can be attached. When threads for the connection of conduit are not tapped all the way through the hole in an enclosure wall, a conduit hub, or the like, there shall not be fewer than five full threads in the metal, and a smooth, rounded inlet hole shall be provided that affords protection for the conductors equivalent to that provided by a standard conduit bushing. The inlet hole shall have an internal diameter the same as that of the corresponding trade size of rigid conduit.

16.1.6 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.

16.1.7 A conduit hub shall be threaded and shall have a wall thickness, before threading, of not less than that of the corresponding trade size of conduit. A conduit hub that is not integral with an enclosure shall not depend upon friction alone to prevent its turning with regard to the enclosure, and shall withstand a torque applied to a short length of rigid metal conduit threaded into the hub in the intended manner without turning the hub and without stripping any thread. The applied torque shall be as specified in [Table 16.2](#).

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).

Table 16.2
Tightening torque

Trade size of conduit, Inches	Tightening torque,	
	pound-inches	(N·m)
3/4 and smaller	800	(90.4)
1, 1-1/4, 1-1/2	1000	(113.0)
2 and larger	1600	(180.8)

16.1.8 A conduit hub shipped with a pump in accordance with [16.1.4\(b\)](#) shall be suitable for wet locations and shall comply with the requirements in the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

16.1.9 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 16.3](#).

Table 16.3
Trade size of conduit in inches

Wire size,		Number of wires		
AWG	(mm ²)	2	3	4
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
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.

16.1.10 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 [58.24](#) are only required to be subjected to the Torque Test of UL 50.

Exception No. 2: Units shipped with a separate hub in accordance with [16.1.4\(b\)](#) and marked in accordance with [58.25](#) are not required to be subjected to the Torque Test of UL 50.

16.2 Terminal compartments

16.2.1 A terminal box or wiring compartment to which branch-circuit connections to a permanently wired pump are to be made shall be located so that the connections can be readily inspected without disturbing the wiring or the pump after installation as intended.

16.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the pump so as to be prevented from turning.

16.2.3 Except as indicated in [16.2.4](#) and [16.2.6](#), the minimum usable volume of a terminal box or compartment in which field-wiring connections to a power supply are to be made shall be as specified in [Table 16.4](#).

16.2.4 If a terminal compartment in which wire-to-wire connections to the power supply are to be made in the field is part of a motor, it shall have minimum cover dimensions and a minimum usable volume in accordance with [Table 16.5](#).

Table 16.4
Minimum usable volume of terminal compartments

Size of conductor,		Volume per power supply conductor, ^a	
AWG	(mm ²)	cubic inches	(cm ³)
14	(2.1)	2.00	(33)
12	(3.3)	2.25	(37)
10	(5.3)	2.50	(41)
8	(8.4)	3.00	(49)
6	(13.3)	5.00	(82)

^a Including a grounding conductor.

Note – The usable volume of terminal compartments should be considered the net volume less the volume of any components located within the terminal compartment such as capacitors, switches, relays, and terminal blocks.

Table 16.5
Motor terminal compartments for wire-to-wire connections

Horsepower (kW output)	Minimum dimensions for cover openings,		Minimum usable volume,	
	inches	(mm)	cubic inches	(cm ³)
1 (0.7) or less ^a	1-5/8	(41)	10.5	(172)
1-1/2, 2, and 3 (1.2, 1.5, and 2.2) ^a	1-3/4	(44)	16.8	(275)
5 and 7-1/2 (3.7 and 5.6)	2	(51)	22.4	(367)
10 and 15 (7.5 and 11.2)	2-1/2	(63.5)	36.4	(597)

^a When the terminal compartment is partially or wholly integral with the frame or end shield, the minimum dimension of the cover opening is not specified, and the volume of the terminal compartment shall be no less than:

- 1) 0.8 cubic inch (13.1 cm³) per wire-to-wire connection for 1 horsepower or smaller motors.
- 2) 1.0 cubic inch (16.4 cm³) per wire-to-wire connection for 1-1/2, 2, and 3 horsepower motors.

Note – The usable volume of terminal compartments should be considered the net volume less the volume of any components located within the terminal compartment such as capacitors, switches, relays, and terminal blocks.

16.2.5 For the purposes of the requirements in [16.2](#), the usable volume of terminal compartments specified in [Table 16.4](#), [Table 16.5](#) and [Table 16.6](#) should be considered the net volume less the volume of any components located within the terminal compartment such as capacitors, switches, relays, terminal blocks, or similar components.

Table 16.6
Terminal compartments for rigidly mounted motor terminals

Power-supply-conductor size,		Minimum usable volume per power-supply connector,	
AWG	(mm ²)	cubic inches	(cm ³)
14 and smaller	(2.1 and smaller)	1	(16.4)
12 and 10	(3.3 and 5.3)	1-1/4	(20.3)
8 and 6	(8.4 and 13.3)	2-1/4	(37)

Note – The usable volume of terminal compartments should be considered the net volume less the volume of any components located within the terminal compartment such as capacitors, switches, relays, and terminal blocks.

16.2.6 When a terminal compartment in which field-wired, power-supply connections are to be made is part of a motor, and encloses rigidly mounted terminals, the terminal compartment shall possess the size to provide spacings in accordance with the requirements in [20.1.1](#) and usable volume in accordance with [Table 16.6](#).

16.2.7 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.

Table 16.7
Tightening torque

Trade size of conduit, inches	Tightening torque,	
	pound-inches	(N·m)
3/4 and smaller	800	(90.4)
1, 1-1/4, 1-1/2	1000	(113.0)
2 and larger	1600	(180.8)

16.2.8 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 16.8](#).

Table 16.8
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.

16.2.9 The terminal enclosure shall have provision for drainage.

16.2.10 The provision for drainage specified in [16.2.9](#) shall be such that drainage of internal condensation does not enter any conduit terminations.

16.2.11 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.

16.3 Field wiring terminals and leads

16.3.1 A permanently connected pump shall be provided with field-wiring terminals acceptable for the connection of conductors having an ampacity appropriate for the pump or the pump shall be provided with acceptable leads for such connections.

16.3.2 A wiring terminal is considered to be a field-wiring terminal unless both the wire and a means of making the connection, such as a pressure terminal connector, a soldering lug, a soldered loop, a crimped eyelet, or the like, are factory supplied and assembled as a part of the pump.

16.3.3 The free length of a lead inside an outlet box or wiring compartment for field connection to the supply conductors shall be at least 6 inches (152 mm).

Exception: The lead may be less than 6 inches long if it is evident that the use of a longer lead may result in a risk of electric shock.

16.3.4 A field-wiring terminal shall be prevented from turning in accordance with [17.2](#) and [17.3](#).

16.3.5 A field-wiring terminal shall be provided with an acceptable soldering lug or pressure terminal connector firmly bolted or held by a screw.

Exception: A wire-binding screw may be used at a wiring terminal intended to accommodate a No. 10 or smaller conductor. If such a binding screw is used, an upturned lug, a cupped washer, or the equivalent shall be provided to hold the wire in position.

16.3.6 An upturned lug or cupped washer shall be capable of retaining a supply conductor of the size intended under the head of the screw or washer above the conductor.

16.3.7 A wire-binding screw shall be no smaller than No. 10.

Exception: A No. 8 screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) conductor. A No. 6 screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm²) conductor.

16.3.8 A terminal plate for a field-wiring binding screw shall be of metal at least 0.050 inch (1.3 mm) thick. There shall be two or more full threads in the plate, which may be extruded if necessary to provide sufficient metal for the threads.

Exception: A plate may be no less than 0.030 inch (0.76 mm) thick if tightening the wire-binding screws with normal torque does not strip the threads from the terminal plate.

16.3.9 A field-wiring terminal shall be acceptable for use with:

- a) Copper conductors only,
- b) Aluminum conductors only, or
- c) Copper or aluminum conductors, and shall be marked as, indicated in [58.16](#).

16.4 Identified terminals and leads

16.4.1 A permanently connected pump rated at 125 or 125/250 volts (3-wire) or less and using an Edison screw-shell lampholder or a single-pole switch or overcurrent protective device other than an automatic control without a marked off position shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The identified terminal or lead shall be the one that is electrically connected to the screw-shells of lampholders and to which no switches or overcurrent protective devices of the single-pole type other than automatic controls without a marked off position are connected.

16.4.2 A field-wiring terminal intended for connection to a grounded supply conductor shall be identified by means of a metallic coating that is essentially white in color and shall be easily 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. If wire leads are provided instead of terminals, the identified lead shall have a white or gray color, and shall be easily distinguishable from the other leads.

16.5 Strain relief

16.5.1 A power-supply cord and a motor-connection cord or cable of a permanently connected pump shall be provided with means to reduce transmittal of tensional or rotational force from the cord to terminals, splices, or wiring within the pump.

16.5.2 The strain relief for a power-supply cord shall reduce flexing or movement of the cord seal, and shall be such that the Strain Relief Tests, Section [51](#), does not result in the water-tight cord seal required by [16.10.6](#) being disturbed.

16.5.3 A metal strain-relief clamp or band may be used, without additional protection, with a cord that is one of the types specified in [16.10.1](#).

16.5.4 Means shall be provided to reduce the likelihood of a flexible cord being pushed into a pump through the cord-entry hole, if such displacement can result in mechanical damage to the cord or exposure of the cord to a temperature higher than its rated temperature or can reduce spacings, such as to a metal strain-relief clamp or bushing, below the minimum acceptable values.

16.5.5 The strain-relief means shall be tested as described in the Strain Relief Tests, Section [51](#).

16.6 Bushings

16.6.1 At a point where a flexible cord passes through an opening in a wall, a barrier, or an enclosure, there shall be bushing that has been investigated and determined to be acceptable, or that which has been determined to be the equivalent, that shall be secured in place and have a smooth, rounded surface against which the cord can bear.

16.7 Contractor pumps

16.7.1 Provisions for supply connections on a submersible contractor pump shall be as described in [16.7.2](#) and [16.7.4](#).

16.7.2 A submersible contractor pump shall be provided with at least 20 feet (6.10 m) of Type SEW, SEOW, SEOOW, SOW, SOOW, STOW, STOOW, or STW cord between the pump and a motor control box.

16.7.3 The flexible cord specified in [16.7.2](#) shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Standard for Flexible Cords and Cables, UL 62.

16.7.4 In addition to the requirement in [16.7.2](#), the control box may be provided with 3 feet (0.91 m) or more of cord of one of the types specified in [16.7.2](#) on the supply side, with strain relief and provision for removal to permit watertight connection of conduit when such connection is necessary. An attachment plug rated for the circuit involved may also be provided.

16.8 Deep-well submersible pumps

16.8.1 The provisions for supply connections on a deep-well submersible pump shall consist of the following, and shall include instructions in accordance with [61.1](#):

- a) At least 1 foot (305 mm) of deep-well cable permanently secured with a watertight seal or
- b) A detachable supply-cable assembly consisting of a female contact connector rated for use with deep-well cable and an acceptable length of deep-well supply cable. The female connector shall be permanently secured and sealed to the cable, and shall mate with a male connector base mounted on the pump.

All seals and connections are to be watertight. The supply-cable assembly shall be packaged with the pump or available from the manufacturer. A box that has been investigated and determined to be acceptable for supply connection, and a control device, may also be provided.

16.9 Sump pumps and portable pumps

16.9.1 Provisions for supply connections on a sump pump or a portable pump shall comply with [16.10.1](#) – [16.10.9](#).

16.10 Cord-connected pumps

16.10.1 A cord-connected pump other than a three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump constructed as described in [16.10.2](#) and [16.10.4](#) shall be provided with at least 6 feet (1.83 m) of permanently attached flexible cord and an attachment plug for connection to the branch-circuit supply. The cord shall:

- a) Be Type SEW, SEOW, SEOOW, SJEW, SJEOW, SJOW, SJOOW, SJTW, SJTOW, SJTOOW, SOW, SOOW, STW, STOW, or STOOW and
- b) Include an equipment-grounding conductor.

Exception No. 1: A submersible fountain pump intended for connection to an underwater junction box or above-ground deck box is not required to have an attachment plug.

Exception No. 2: A permanently installed pump complying with [16.1.2](#) or its Exception shall be provided with a length of flexible cord suitable for the intended use of the pump.

16.10.2 A three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump shall be provided with at least 6 feet (1.83 m) of permanently attached flexible cord. The cord shall:

- a) Be Type SEW, SEOW, SEOOW, SJEW, SJEOW, SJOW, SJOOW, SJTW, SJTOW, SJTOOW, SOW, SOOW, STW, STOW, or STOOW and
- b) Include an equipment-grounding conductor. The cord shall also be provided with:

- 1) An attachment plug for connection to the branch circuit supply or
- 2) A junction box, outlet box, enclosure with a wiring compartment that complies with the requirements of [16.2.3](#), or similar container, and applicable fittings for supply connection. Such provision for supply connection shall reduce the risk of water entry during temporary, limited submersion and shall comply with the applicable requirements of the Standard for Enclosures for Electrical Equipment, UL 50, or the Standard for Metallic Outlet Boxes, UL 514A, and this standard.

Exception No. 1: Provision for supply connection with the cord specified in (b)(2) is not required when:

- a) The pump is marked in accordance with [58.19](#) and*
- b) The installation instructions provided with the pumps are in accordance with [61.5](#).*

Exception No. 2: Single-phase cord-connected sewage, effluent, and grinder pumps that are intended to be connected to a branch circuit outlet receptacle shall be provided with an attachment plug.

Exception No. 3: The flexible cord is not required to be permanently attached if the inlet and molded-on cord connector comply with the applicable requirements of Standard for Cable Assemblies and Fittings for Industrial Control and Signal Distribution, UL 2238 including the 5 ft.-lb. impact test when assembled and be suitable for continuous immersion. The connector-inlet connection shall require the use of tools for disconnection.

16.10.3 The flexible cord specified in [16.10.1](#) and [16.10.2](#) 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.

16.10.4 A three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump specified in [16.10.2](#) that is intended for use with a fixed wire electrical control device shall either be shipped from the factory with the fixed wire electrical control device or shall be marked to indicate that an acceptable motor control must be provided at the time of installation in accordance with [58.20](#). The control device shall have suitable electrical ratings in volts, amperes, frequency and horsepower for the pump it controls.

16.10.5 With reference to [16.10.2](#), the cord shall be provided with strain relief and the pump shall be marked in accordance with [58.21](#) and provided with installation instructions in accordance with [61.7](#).

16.10.6 A flexible cord shall enter the enclosure of a submersible pump through a watertight cord seal.

16.10.7 A flexible cord shall be rated for use at a voltage not less than the rated voltage of the pump and shall have an ampacity no less than the ampere rating of the pump.

16.10.8 An attachment plug shall be of a grounding type acceptable for use with a current not less than 125 percent of the rated pump current, and at a voltage at least equal to the rated voltage of the pump. If the pump is rated for use on two or more voltages by field alteration of internal connections, the attachment plug provided with the pump shall be rated for the voltage for which the pump is connected when shipped from the factory.

Exception: A three-phase, cord-connected submersible pump constructed in accordance with [16.10.2](#) is not required to comply with this requirement.

16.10.9 A 3-to-2 wire, grounding-type adapter shall not be provided with a pump.

16.11 Fountain pumps

16.11.1 A submersible pump shall have a flexible cord as described in [16.10.1](#). If such a pump is intended for outdoor use, the cord shall also comply with the requirement in [16.10.1](#).

16.11.2 A nonsubmersible pump shall have wiring terminals or leads within a wiring compartment having provisions for connection to a wiring system that has been investigated and determined to be acceptable for the pump.

16.11.3 The instructions for a fountain pump having a flexible cord of other than Type SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, or STOOW shall include a warning as specified in [61.4](#).

16.11.4 The end of the flexible cord jacket and the flexible cord conductor termination, and the ground connection shall be covered with, or encapsulated in, a potting compound.

16.12 Elevator hoistway sump pumps

16.12.1 Submersible pumps intended for use in elevator hoistway sumps shall be provided with a supply cord of type SJEOW, SJEOOW, SJOW, SJOOW, SJTOW, SJTOOW or equivalent oil-resistant hard-usage type. The length shall not exceed 6 ft.

17 Current-Carrying or Live Parts

17.1 A current-carrying part shall be of silver, copper, a copper-base alloy, stainless steel, aluminum, or other materials that have been investigated and determined to be acceptable for the application.

Exception: Plated steel may be used for a primary circuit part, such as a capacitor terminal where a glass-to-metal seal is required, and for a lead or threaded stud of a semiconductor device. Blued steel or steel with equivalent resistance to corrosion may be used for a current-carrying arm of a mechanically- or magnetically-operated leaf switch. Plated steel may be used within a motor and its governor (including motor terminals) or where the operating temperature of the part is in excess of 100°C (212°F). These materials shall not be used for other current-carrying applications.

17.2 An uninsulated live part or a component involving an uninsulated live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting position so as to reduce electrical spacings below the minimum values. Quick-disconnect terminal blades shall be fixed, and connections to them shall be provided with a mating detent.

17.3 Friction between surface shall not be used as a sole means for preventing shifting or turning as required by [17.2](#), but a properly applied lock washer may be used.

18 Insulating Material

18.1 An uninsulated live part shall be mounted on porcelain, phenolic composition, or other material that has been investigated and determined to be acceptable for the application.

18.2 A moisture absorptive material shall not be used for electrical insulation where shrinkage, water absorption, or warpage may introduce a risk of fire, electric shock, or injury to persons. A thermoplastic material may only be used for sole support of uninsulated live parts if found to have mechanical strength, rigidity, aging properties, heat resistance, flame propagation resistance, dielectric strength, and other appropriate properties that have been determined to be acceptable for the application.

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

18.4 A printed-wiring board, where loosening of the bond between the conductor and the base material may result in contact between uninsulated primary circuit parts, shall comply with the applicable requirements in the Standard for Printed-Wiring Boards, UL 796.

19 Internal Wiring

19.1 Mechanical protection

19.1.1 Internal wiring and connections between parts shall be guarded or enclosed.

19.1.2 Wiring shall be protected from sharp edges including screw threads, burrs, fins, moving parts, and the like, that may abrade the insulation on conductors or otherwise damage the wiring.

19.1.3 It is not prohibited for a pump that complies with the requirements in [16.1.2](#) to be provided with a short length of cord and an attachment plug that comply with the requirements in [16.10.7](#) and [16.10.8](#) for connection to a receptacle in a supply connection or control box. See [28.10](#).

19.1.4 All wiring shall be protected from damage and separated by nonflammable material from flammable material other than insulating oil.

19.1.5 A hole in a metal wall through which insulated wires pass shall be provided with a smoothly rounded bushing as described in [16.6.1](#), or the hole shall have smooth surfaces, free of burrs, fins, sharp edges, and the like, upon which the wires may bear without damage to the insulation.

19.1.6 With reference to exposure of insulated wire through an opening in the enclosure of a pump, the protection of such wiring required by [19.1.1](#) is acceptable if, when judged as though it were film-coated wire, the wiring would be acceptable under the requirements in [15.4](#). Wiring not protected as described in this paragraph may be acceptable if it is:

- a) In a permanently-wired pump and
- b) Secured within the enclosure so that it is unlikely to be subjected to stress or physical abuse.

19.1.7 Insulated internal wiring, including the equipment-grounding conductor, shall consist of wire of a type acceptable for the application when considered with regard to:

- a) The temperature and voltage involved;
- b) Exposure to oil, grease, and other substances which have a deleterious effect on the insulation;
- c) Exposure to moisture; and
- d) Other anticipated considerations of actual service.

19.1.8 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.

19.2 Splices and connections

19.2.1 A splice or a connection shall be made mechanically secure and shall provide electrical contact. A soldered connection shall be made mechanically secure before soldering if breaking or loosening of the connection may result in a risk of fire, electric shock, or injury to persons.

19.2.2 In the case of a pump in which excessive vibration is likely to be present, the requirement in [19.2.1](#) requires the use of one or more lock washers or other similar means to prevent a wire-binding screw or nut from loosening.

19.2.3 A splice shall be provided with insulation equivalent to that of the wires involved if the permanence of spacing between the splice and other metal parts may not be maintained.

19.2.4 An aluminum conductor, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method acceptable for the combination of metals involved at the connection point.

19.2.5 If a wire-binding screw construction, or a pressure-wire connector is used as a terminating device, it shall be acceptable for use with aluminum under the conditions involved, such as temperature, heat cycling, vibration, and the like.

19.2.6 Insulation consisting of two or more layers of friction tape, two or more layers of thermoplastic tape, or of one layer of friction tape on top of one layer of rubber tape is acceptable on a splice if the voltage involved is less than 250 volts. In evaluating the use of coated fabric, thermoplastic, or other types of tubing, consideration is to be given to dielectric properties of the material, heat- and moisture-resistance characteristics, and other appropriate factors. Thermoplastic tape is not acceptable if wrapped around or over a sharp edge. Oil resistance of all types of insulation used with an oil-filled enclosure shall be considered in evaluating their acceptability.

19.2.7 When stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands cannot contact other uninsulated metal parts not always of the same polarity. This may be accomplished by the use of a pressure terminal connector, a soldering lug, a crimped eyelet, soldering the strands together, or by other similar means.

20 Spacings

20.1 At field-wiring terminals

20.1.1 The spacings between field-wiring terminals of opposite polarity and between a field-wiring terminal and a dead metal part that may be grounded shall not be less than the values specified in (a) or (b). The following spacings apply to the sum of the spacings involved where an isolated noncurrent-carrying metal part is interposed:

- a) Through air or over surface where a potential of 250 volts or less is involved, 1/4 inch (6.4 mm).
- b) Through air or over surface where a potential of more than 250 volts is involved, 3/8 inch (9.5 mm).

20.1.2 The spacings in [20.1.1](#) shall be evaluated with the anticipated conduit or cable fittings and locknuts installed. These shall be considered grounded metal parts.

20.2 In a motor

20.2.1 Spacings within a motor are judged under the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

20.3 Spacings other than in a motor or at field-wiring terminals

20.3.1 At a point other than a field-wiring terminal, and in a motor, the spacings between live parts of opposite polarity and between an uninsulated live part and a dead metal part that is exposed to contact by persons or that may become grounded shall be no less than specified in [Table 20.1](#). If a live part is not fixed in position by means other than friction between surfaces, or if a dead metal part is likewise movable, the construction shall be such that the minimum acceptable spacings will be maintained.

Exception: The inherent spacings of a component, such as a snap switch, are judged on the basis of the requirements for the component in question.

Table 20.1
Spacings at points other than in a motor or at field-wiring terminals

Potential, volts	Minimum spacings			
	Over surface,		Through air,	
	inch	(mm)	inch	(mm)
0 – 250	1/4 ^a	(6.4)	3/32 ^a	(2.4)
251 – 600	3/8 ^a	(9.6)	1/4 ^a	(6.4)

^a Film-coated wire is considered to be an uninsulated live part; however, a spacing of no less than 3/32 inch is acceptable over surface and through air between film-coated wire supported so as to maintain the spacings or held in place on a coil and a dead metal part.

20.3.2 If an isolated dead metal part is interposed between or is in close proximity to live parts of opposite polarity, a live part and an exposed dead metal part, or a live part and a dead metal part that may be grounded; the spacing shall be no less than 3/64 inch (1.2 mm) between the isolated dead metal part and any one of the parts previously mentioned, if the total spacing between the isolated dead metal part and the two other parts is no less than specified in [Table 20.1](#).

20.3.3 An insulated lining or barrier of vulcanized fiber or similar material used where a spacing would otherwise be less than the minimum shall not be less than 1/32 inch (0.8 mm) thick and shall be so located or of such material that it will not be adversely affected by arcing.

Exception No. 1: Vulcanized fiber not less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air-spacing of not less than 50 percent of the minimum through-air spacing.

Exception No. 2: Insulating material thinner than that specified may be used if investigated and found to be acceptable for the application.

20.3.4 The spacing between an uninsulated live part in a line-voltage circuit and an uninsulated live part in a low-voltage circuit shall comply with the requirements for spacing between parts of opposite polarity in [20.1.1](#), [20.3.1](#), and [20.3.2](#), and shall be based on the highest voltage involved.

20.3.5 For other than providing isolation between different circuits, in a safety circuit, or as defined in Secondary Circuits, Section [SC1](#), spacings between traces of different potential on a printed wiring board are not required to comply with the spacing requirements of this Standard when:

- a) The printed wiring board has a flammability rating of V-0.
- b) The printed wiring board base material has a minimum Comparative Tracking Index (CTI) Performance Level Category rating of 2 in accordance with the requirements in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.
- c) The equipment complies with the Printed wiring board abnormal operation test, [SC3.5](#).

21 Insulating Barriers

21.1 When a barrier is used to comply with spacing requirements, the insulating material used shall comply with at least one of the following criteria:

- a) Be a generic direct support material provided in the thickness indicated in [Table 21.1](#);
- b) Be a generic barrier material provided in the thickness indicated in [Table 21.1](#) when the insulating barrier does not physically support or maintain the relative position of the uninsulated parts involved; or
- c) Comply with the Electrical Insulation requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C at a thickness that meets at least one of the following:
 - 1). Not less than 0.028 inch (0.71 mm) thick;
 - 2) Not less than 0.013 inch (0.33 mm) thick plus one-half required clearance spacings when the barrier is provided in lieu of required clearance distance only; or
 - 3) Capable of withstanding the 5000 V ac Dielectric Strength Test in accordance with the internal barrier requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Table 21.1
Generic materials suitable as a barrier

Generic material	Minimum thickness,		RTI, °C
	Inch	(mm)	
Aramid Paper	0.010	(0.25)	105
Cambric	0.028	(0.71)	105
Electrical Grade Paper	0.028	(0.71)	105
Epoxy	0.028	(0.71)	105
Mica	0.006	(0.15)	105
Mylar (PETP)	0.007	(0.18)	105
RTV	0.028	(0.71)	105
Silicone	0.028	(0.71)	105
Treated Cloth	0.028	(0.71)	105
Vulcanized Fiber	0.028	(0.71)	105
NOTE – Each material shall have at least the minimum thickness specified and its Relative Thermal Index (RTI) value shall not be exceeded during the Temperature Test, Section 40 .			

22 Clearance and Creepage Distances

22.1 As an alternative approach to the spacing requirements specified in Spacings, Section 20, and other than as noted in 22.2, 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 and 22.4.

22.2 The clearance and creepage distance at field wiring terminals shall be in accordance with the requirements in Spacings, Section 20.

Exception: If the design of the field wiring terminals is such that it will preclude the possibility of reduced spacing due to stray strands or improper wiring installation, clearances and creepage distances at the field wiring terminal may be evaluated in accordance with the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840.

22.3 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) For evaluating clearances:

1. Pumps intended to be permanently wired to their supply shall be evaluated for Overvoltage Category III. This includes shallow and deep-well submersible pumps. Portable and permanently installed pumps provided with a cord in accordance with 16.1.2 shall be 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 .

b) 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.

22.4 Clearances between an uninsulated live part and the walls of a metal enclosure shall be determined with a conduit fitting and locknut installed.

23 Separation of Circuits

23.1 Separation between different internal wiring circuits (factory-installed conductors)

23.1.1 Insulated conductors shall be segregated or separated by barriers from each other.

Exception: Conductors provided with insulation rated for the highest voltage involved are not required to be segregated or separated.

23.1.2 Insulated conductors shall be segregated or separated by barriers from uninsulated live parts connected to different circuits.

23.1.3 Segregation accomplished by clamping, routing, or equivalent means that provides a minimum permanent 1/4-in (6.4-mm) separation between applicable conductors is considered to comply with [23.1.2](#).

23.2 Separation between different field wiring circuits (field-installed conductors)

23.2.1 The appliance shall be constructed so that field-installed conductors of any circuit are segregated – see [23.4](#) – or separated by barriers – see [23.5](#) – from field-installed conductors connected to any other circuit.

Exception No. 1: Segregation or separation is not required between conductors of different Class 2 circuits when:

- a) Testing and/or analysis shows that, due to the breakdown of a single spacing or single component fault, the resulting circuit complies with the requirements applicable to a single isolated secondary circuit and*
- b) The equipment complies with the applicable requirements of this standard when incorporating the isolated secondary circuit that results from the failure of a single spacing or single component fault.*

Exception No. 2: Segregation or separation is not required between conductors of a Class 2 circuit and a non-limited energy power circuit provided that:

- a) The Class 2 conductors are intermingled in order to accommodate the connection of the limited energy circuit to the appliance;*
- b) The non-limited energy circuit is 150 Vac or less to ground; and*
- c) The appliance is marked to indicate that the Class 2 circuit is to be wired with Types CL3, CL3R, CL3P, or the equivalent conductors as shown in . See [58.28](#).*

Exception No. 3: Segregation or separation is not required between conductors of a Class 2 circuit and a non-limited energy power circuit provided that:

- a) The Class 2 conductors are intermingled in order to accommodate the connection of the limited energy circuit to the appliance;*
- b) The non-limited energy circuit is 150 Vac or less to ground; and*
- c) The appliance is marked to indicate that the Class 2 circuit is to be wired with conductors suitable for Class 1, or Power circuits. See [58.29](#).*

Table 23.1
Cable substitutes for Type CL3, CL3P, and CL3R cables

Cable type	Cable substitutes
CL3	CL3P, CL3R, CM, CMG, CMP, CMR, FPL, FPLP, FPLR, and PLTC
CL3P	CMP and FPLP
CL3P	CL3P, CMP, CMR, FPLP, and FPLR

23.3 Separation between field wiring circuits (field-installed conductors) and internal wiring circuits (factory-installed conductors)

23.3.1 Separation between field-installed conductors and factory-installed conductors shall be as described in [23.2](#).

Exception No. 1: Factory-installed conductors that can intermingle with field-installed conductors shall be provided with insulation rated for the highest voltage of either circuit.

Exception No. 2: In addition to the requirements in [23.2](#), a pump that permits field-installed conductors to intermingle with factory-installed conductors shall be marked to indicate that the field-installed conductors are to be provided with insulation rated for the highest voltage of either circuit. See [58.28](#), [58.29](#), and [58.27](#).

23.3.2 Insulated field-installed conductors shall be segregated or separated by barriers from uninsulated live parts connected to a different circuit.

Exception No. 1: Insulated non-limited energy field-installed conductors are not prohibited from contacting wiring terminals of different non-limited energy circuits.

Exception No. 2: Field-installed conductors of a limited energy circuit are not prohibited from contacting terminals of a different limited energy circuit provided that the short-circuiting of the terminals does not result in a risk of fire, electric shock, or injury to persons.

23.4 Segregation methods

23.4.1 Segregation accomplished by clamping, routing, or equivalent means that provides a minimum permanent 1/4-in (6.4-mm) separation between applicable conductors complies with [23.2.1](#) and [23.3.1](#).

23.4.2 When field-installed conductors are segregated in accordance with [23.4.1](#), the segregation of the conductors complies with [23.4.1](#) when the segregation is from each other, from uninsulated live parts and from factory-installed conductors by locating openings in an enclosure for the various conductors – with respect to the terminals or other uninsulated live parts – so that a minimum permanent 1/4-in (6.4-mm) separation is provided.

23.4.3 With reference to [23.4.2](#), if the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the appliance, and if each opening is located opposite a set of terminals, a conductor entering an opening shall be connected to the terminal opposite that opening. If more than the minimum number of openings are provided, the effect of a conductor entering an opening other than the one opposite the terminal to which the conductor is intended to be connected and the likelihood of the conductor contacting insulated conductors or uninsulated live parts connected to a different circuit is to be investigated.

23.4.4 To determine if the appliance complies with [23.4.1](#), [23.4.2](#), and [23.4.3](#), the appliance is to be wired as intended for service with:

- a) Six to twelve in of slack left in each conductor and
- b) No more than average care exercised in stowing the slack into the wiring compartment.

23.5 Separation methods

23.5.1 With respect to [23.2.1](#) and [23.3.1](#), if the intended uses of the unit is such that in some applications a barrier is required while in some other applications no barrier is required, a removable barrier or one having openings for the passage of conductors is not prohibited. Instructions for the use of such a barrier shall be a permanent part of the appliance. Complete instructions in conjunction with a wiring diagram is not prohibited from being used in lieu of a barrier if, upon investigation, the combination is determined to comply with these requirements.

23.5.2 Conductors from a non-limited energy power field-installed circuit and from a Class 2 field-installed circuit that are routed through a single opening in an enclosure of a permanently connected appliance complies with the intent of [23.2.1](#) if the Class 2 conductors are separated from the non-limited energy conductors by a continuous and firmly fixed nonconductor such as flexible tubing. Tubing that complies with the Standard for Extruded Insulating Tubing, UL 224, is acceptable. The voltage rating of the tubing shall not be less than the maximum voltage rating of the non-limited energy conductors. The tubing shall be provided as part of an installation kit with the appliance. See [58.30](#).

24 Grounding

24.1 General

24.1.1 A pump shall have provision for grounding all dead metal parts that could become energized.

Exception: A non-submersible pump provided with a system of double insulation as specified in Double insulation, [24.4](#), is not required to have provision for grounding.

24.1.2 A cord-connected pump shall be provided with a power-supply cord and a grounding attachment plug. A single-phase pump shall use a three-wire cord; a three-phase pump shall use a four-wire cord. The single conductor of the cord that terminates in the grounding pin of the attachment plug shall have insulation colored green or green with one or more yellow stripes. Grounding conductors are not required to be sized larger than the circuit conductors used to supply the pump. This conductor shall terminate at the pump end with a connection to a screw or a connector that is not disturbed during servicing of the pump other than servicing of the power-supply cord. Sheet-metal screws shall not be used to connect grounding conductors to enclosures.

Exception: Small potted pumps and similar constructions not intended for the pump cord to be removed and replaced may terminate the equipment-grounding conductor by permanent means such as brazing, welding, or riveting. Solder shall not be relied upon for the reliability of the bonding path.

24.1.3 A three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump constructed in accordance with [16.10.2](#) is not required to be provided with an attachment plug. The grounding conductor of the cord shall have insulation colored green or green with one or more yellow stripes. This conductor shall be connected at the pump end to a screw or a connector that has a remote possibility of being disturbed during servicing of the pump other than servicing of the power-supply cord.

24.1.4 A box or wiring compartment for permanent connection of a pump to its electrical supply source shall be provided with a green colored lead at least as large as the circuit conductors, or a terminal screw or a wire connector to secure such a lead shall be provided. For 10 AWG (5.3 mm²) or smaller wire, a green, hexagonal-headed (or slotted, or both) wire-binding screw with the equivalent of upturned lugs is not prohibited from being used.

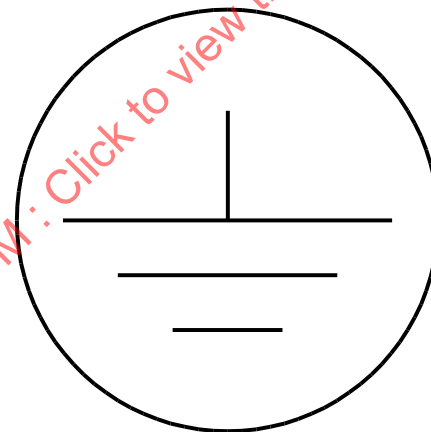
24.1.5 A pressure-wire connector intended for connection of an equipment-grounding conductor shall be identified by:

- a) Being marked "G," "GR," "Ground," "Grounding," or similar marking;
- b) A marking on a wiring diagram provided on the product; or
- c) The symbol shown in [Figure 24.1](#) located on or adjacent to the connector, or on a wiring diagram provided on the product. See [24.1.6](#).

24.1.6 When the symbol shown in [Figure 24.1](#) is used in accordance with [24.1.5\(c\)](#), the installation instructions provided with the product shall include a definition of the symbol.

Exception: When the symbol in [Figure 24.1](#) is used with one of the other means of identification specified in [24.1.5 \(a\)](#) and [\(b\)](#), the definition is not required to be provided.

Figure 24.1
Grounding symbol



UL0005B

24.2 Bonding

24.2.1 A noncurrent-carrying metal part shall be bonded to the point of connection of the grounding conductor. For a pump equipped with a box for supply connections that is remote from the motor or pump, a green colored lead in the interconnecting cable, terminated as described in [24.1.2](#), may be used for bonding. A submersible deep-well or shallow-well pump may be provided with a green-identified deep-well cable conductor the same size as the circuit conductors or with terminals on both the outside of the pump housing and the inside or outside of the supply connection box (when provided). The grounding terminal shall comply with the requirements in [24.1.4](#).

24.2.2 Solder alone shall not be used to secure grounding and bonding connections. Means for accomplishing bonding and grounding shall penetrate all nonconductive coatings such as paint.

24.2.3 A bolted or screwed connection that incorporates a star washer under a screw head, a serrated screw head, or the equivalent is acceptable for penetrating nonconductive coatings as required by [24.2.2](#).

24.2.4 If the bonding means depends upon screw threads, two or more screws, or two full threads of a single screw engaging metal comprise acceptable means of compliance with the requirement in [24.2.2](#).

24.2.5 The size of a conductor or a strap used to bond an electrical enclosure of a motor frame shall be based on the rating of the branch-circuit overcurrent-protective device by which the equipment is intended to be protected. The size of the conductor or strap shall be in accordance with [Table 24.1](#).

Exception: A clamp or a strap is acceptable if it complies with the requirements in [24.2.6](#).

Table 24.1
Bonding wire conductor size

Rating of branch-circuit overcurrent-protective device, amperes	Minimum size of bonding conductor ^a			
	Copper wire,		Aluminum wire,	
	AWG	(mm ²)	AWG	(mm ²)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	6	(13.3)

^a Or equivalent cross-sectional area.

24.2.6 A conductor, such as a clamp or a strap, used in place of a separate wire conductor as indicated in [24.2.5](#), is acceptable if the cross-sectional area of the conductor is at least that of the wire size indicated in [Table 24.1](#).

24.2.7 A type of bonding connection other than those described in [24.2.3](#) – [24.2.5](#) may be used if the connection does not open when carrying a current of 135 and 200 percent of the rating of the appropriate branch-circuit protective device for the time specified in [Table 24.2](#).

Table 24.2
Duration of overcurrent test

Rating or setting of branch-circuit overcurrent-protective device, amperes	Test time, minutes	
	135 percent current ^a	200 percent current ^a
0 – 30	60	2
31 – 60	60	4
61 – 100	120	6
101 – 200	120	8

^a If a 600-volt fuse rated at 100 amperes or less and plainly marked "For Use Only on Motor Circuits" is to be used, test time shall be 8 minutes.

24.2.8 A bonding conductor may be bare.

24.2.9 A splice in wire conductors used to bond electrical enclosures, motor frames, or other electrical components shall be mechanically and electrically secure, and solder alone shall not be relied upon.

24.2.10 The resistance between the point of connection of the equipment-grounding means, at or within the unit, and any other point required to be grounded shall be no more than 0.1 ohm.

24.2.11 Compliance with the requirement in [24.2.10](#) may be determined by any acceptable instrument, such as an ohmmeter or bridge.

Exception: If unacceptable results are recorded using the means mentioned in this paragraph, an alternating current of at least 30 amperes from a power supply of no 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 between these points is to be measured. The resistance is then to be calculated using Ohm's Law. The grounding conductor of the power-supply cord is not to be included in this measurement.

24.3 Grounding identification

24.3.1 Insulation or other covering on a bonding conductor shall be green in color, with or without one or more yellow stripes.

24.3.2 If a pump is provided with leads, and one lead is an insulated or covered equipment-grounding conductor, the color of that lead shall be green or green with one or more yellow stripes, and other leads shall be of a color or colors other than, and shall contrast with, the equipment-grounding conductor.

24.4 Double insulation

24.4.1 A non-submersible pump protected by a system of double insulation in accordance with the Exception to [24.1.1](#) shall comply with the requirements in the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, and shall not be provided with a means for grounding.

24.4.2 In the application of the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, the water being pumped shall be considered to be:

- a) A conductive part and
- b) Accessible to the user.

24.4.3 Double insulated pumps shall be marked in accordance with [58.26](#) and [58.27](#), and be provided with the instructions in [62.1\(c\)](#).

24.4.4 In addition to the dielectric voltage-withstand tests of the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, an additional dielectric voltage withstand test of 2000 V plus twice the rated voltage of the pump shall be conducted between inaccessible metal that could become energized in a fault of the basic insulation system and the water being pumped. If the pump casing is of insulating material electrical contact with the water shall be through a copper electrode consisting of two turns of bare 14 AWG (2.1 mm²) 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. The water is to have a resistivity of 2540 ohm-centimeters.

24.4.5 The probe specified in [24.4.4](#) shall also be used to measure leakage current to the water in accordance with the Leakage Current Test of the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

25 Motors

25.1 Construction

25.1.1 A motor shall be acceptable for the application and shall drive its maximum normal load without introducing any risk of fire, electric shock, or injury to persons.

25.1.2 A motor winding shall resist the absorption of moisture.

25.1.3 With reference to the requirement in [25.1.2](#), film-coated wire is not required to be additionally treated to resist absorption of water, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or other treatment to resist the absorption of water.

Exception: An oil-filled motor requires no absorption-retardant treatment.

25.1.4 In the application of requirements based on horsepower for a motor not rated in horsepower, reference is to be made to [Table 50.1](#) and [Table 50.2](#), as appropriate. For a universal motor, the table applying to a single-phase, alternating-current motor is to be used if the motor is marked for use on alternating current only; otherwise, the table applying to a direct-current motor is to be used.

25.1.5 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 Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series, is considered to fulfill the Motors Provided With Controls requirements of UL 1004-1.
- c) See [10.1.12](#) 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 Electrical and Fire Enclosures, Section [10](#).
- e) Grounding requirements of UL 1004-1 are superseded by the requirements of Grounding, Section [24](#).
- f) The Ventilation Opening requirements of UL 1004-1 are only applicable where the openings are on surfaces considered to be the appliance enclosure.
- g) The Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts requirements of UL 1004-1 is superseded by Section [15](#).
- h) The Protection Against Corrosion requirements of UL 1004-1 are superseded by Section [14](#).
- 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.

25.2 Overload protection

25.2.1 A pump or its control shall incorporate thermal or overload protection against running-overload and stalled-rotor conditions complying with the requirements in [25.2.2](#) and [25.2.3](#).

Exception: A permanently-connected or permanently-installed pump that is intended for use with a separate overload device that is responsive to motor current per Article 430 of the National Electrical Code (NEC) ANSI/NFPA 70-2011 and is marked in accordance with [58.11](#), is not required to comply with this requirement.

25.2.2 The overload protection required by [25.2.1](#) shall consist of one of the following:

- a) 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;
- b) Permanently-connected or permanently installed units intended for use with a separate overload protection device that is responsive to motor current that is provided with protection in accordance with [26.2](#); or
- c) Permanently-connected or permanently installed units intended for use with a separate overload protection device that is responsive to motor current and is provided with electronic overcurrent protection complying with [26.2](#) 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; or
- d) Electronic protection that complies with the requirements of the Standard for Electronically Protected Motors, UL 1004-7; or
- e) Other protection, such as that requiring immersion of a submersible motor, that is shown by test to be equivalent to the protection specified in (a) and (b), or
- f) An electronic circuit that complies with the tests of UL 1004-3 and the requirements of the UL 60335-1 –Based Requirements for the Evaluation of Electronic Circuits, Supplement [SB](#), or
- g) An electronic circuit that complies with the tests of UL 1004-3 and the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.
- h) Impedance protection complying with the requirements in the Standard for Impedance Protected Motors, UL 1004-2.

25.2.3 A 3-phase motor shall be provided with overload protection as follows:

- 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.

26 Overload-Protective Devices

26.1 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.

26.2 A separate device incorporated in a pump in accordance with the requirements in [25.2.2\(b\)](#), shall be responsive to motor current and shall be rated or set in accordance with [Table 26.1](#) (column A).

Exception: If the rating of the device determined in accordance with [Table 26.1](#) (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 26.1](#) (column B). For a multispeed motor, each winding connection is to be considered separately.

Table 26.1
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.

26.3 With reference to the requirements in [26.2](#), each winding connection of a multispeed motor shall be considered separately.

26.4 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.

26.5 A fuseholder or circuit breaker shall be acceptable for the application.

26.6 If a circuit breaker handle is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

26.7 A plug fuseholder intended for the fuses mentioned in [26.1](#) shall be Type S or shall be Edison-base with a factory-installed, nonremovable Type S adapter.

26.8 An overload-protective device shall not open the circuit during normal operation of the pump.

26.9 To determine whether a submersible pump that is constructed for water-flow through or past the motor complies with the requirement in [25.2.2](#), it shall be tested under the maximum normal load conditions described in the Temperature Test, Section [40](#), with the load controlled by adjustment of the head by means of a valve in the output line of the pump. Locked-rotor tests shall be conducted with the rotor of the motor locked in position.

26.10 If compliance with the requirement in [25.2.1](#) depends on an attached auxiliary part of the enclosure, such as a rain shield or a drip canopy, the part shall be attached so that removal will

necessitate the use of tools. A friction or mechanical fit is acceptable if removal of the part during installation and normal handling is unlikely.

26.11 A protective device shall be wholly inaccessible from outside the unit without opening a door or cover.

Exception: The operating handle of a circuit breaker, the operating button of a manually operated motor protector, and similar parts may project outside the enclosure of the unit.

26.12 Opening a door that gives access to a protective device shall not expose live parts other than the screw shell of an Edison-base fuseholder. Such a screw shell, or the cap of an extractor-type fuseholder, shall be connected toward the load.

26.13 No replaceable protective device other than an extractor-type fuse shall be used in a portable household pump.

26.14 The functioning of a motor-protective device shall not result in any risk of fire, electric shock, or injury to persons.

27 Capacitors

27.1 A capacitor provided as part of a capacitor motor, and a capacitor connected across the line, such as one for radio-interference suppression or power-factor control, shall be housed within an enclosure or container that will protect the plates from mechanical damage and reduce the emission of flame or molten metal resulting from malfunction or breakdown of the capacitor.

27.2 The container mentioned in [27.1](#) shall be of sheet steel not less than 0.020 inch (0.5 mm) thick or shall be constructed to afford equivalent protection. A nonmetallic or magnesium enclosure shall comply with the requirements in [10.1.11](#).

Exception No. 1: An individual container of a capacitor may be of sheet metal that is not as thick as that specified, or may be of other material that has been investigated and determined to be acceptable if the capacitor is intended to be mounted in an enclosure that houses other parts of the pump, and if such an enclosure has been investigated and determined to be acceptable to enclose live parts.

Exception No. 2: An individual enclosure of an electrolytic capacitor with means for venting is required to provide protection against mechanical damage only, and the requirement for minimum enclosure thickness does not apply. An 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 need not comply with the enclosure thickness requirement if it successfully completes the following test:

- a) Samples of the capacitor, mounted in the usual manner, and with cotton placed around openings in the enclosure are subjected to such overvoltage as is necessary to cause breakdown.*
- b) If the cotton ignites upon breakdown, the results are unacceptable, and the enclosure thickness requirements shall apply.*

27.3 A capacitor connected between two line conductors in a primary circuit, or between one line conductor and the neutral conductor or between primary and accessible secondary circuits or between the primary circuit and protective earth (equipment grounding conductor connection) shall comply with one of the subclasses of the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14 and shall be used in accordance with its rating.

Note – Details for damp heat, steady state test can be found in 4.12 of IEC 60384-14.

27.4 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.

28 Switches and Controls

28.1 A switch or other electrical control shall be acceptable for the application, with a rating no less than that of the load it controls. The voltage and current rating shall also correspond with the type of load controlled.

28.2 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.

28.3 Switches that comply with the Standard for Switches for Appliances – Part 1: General Requirements, CAN/CSA-C22.2 No. 61058-1 or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1 shall be rated as specified in [28.3](#) – [28.5](#).

28.4 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 Clause 7.1.2.2 of the Standard for Switches for Appliances – Part 1: General Requirements, CAN/CSA-C22.2 No. 61058-1 or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or the 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 Clause 7.1.2.5 of the Standard for Switches for Appliances – Part 1: General Requirements, CAN/CSA-C22.2 No. 61058-1 or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or the Outline of Investigation for Particular Requirements for Switches for Tools, 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.

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

28.6 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 the Standard for Switches for Appliances – Part 1: General Requirements, CAN/CSA-C22.2 No. 61058-1 or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

28.7 Float- and pressure-operated switches shall comply with the applicable requirements in the Standard for Industrial Control Equipment, UL 508 or the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

28.8 If the handle of a switch is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

28.9 A through-cord switch that is not intended for remote mounting – one in which the supply cord passes through the body of the switch and has one or more conductors broken for the purpose of switching – shall not be used with a pump.

Exception: A submersible sump pump may use a through-cord float-type switch.

28.10 A portable pump using a motor rated more than 1/3 horsepower (249-watt output) shall use a manually-operated motor-control switch mounted on the pump.

Exception: A pump that is marked in accordance with [58.12](#) and on which a motor control switch would be inaccessible is not required to comply with this requirement. For a pump constructed in accordance with [19.1.3](#), the control switch is to be in the box accommodating the motor receptacle.

28.11 Electronic motor drives, if provided, shall be suitable for the pump voltage and current rating and shall comply with the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1; or the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 or the Electronic Circuits requirements in Supplement [SB](#).

29 Line Voltage Submersible Pumps with Submersible Luminaires

29.1 Submersible pumps intended for use in portable fountains are not prohibited from being provided with cord or cable connected low-voltage luminaires. If provided they shall comply with [29.2](#) – [29.8](#).

29.2 The luminaires shall comply with:

a) The requirements for submersible luminaires in the Standard for Underwater Luminaires and Submersible Junction Boxes, UL 676;

b) The requirements for submersible luminaires in the Standard for Low Voltage Landscape Lighting Systems, UL 1838; or

c) The Water Barrier requirements in the Standard for Low Voltage Landscape Lighting Systems, UL 1838 and the Low-voltage luminaire dry operation test specified in [53.4](#).

29.3 The pump shall be provided with either:

- a) A transformer that complies with the requirements for a Class 2 transformer specified in the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3; or
- b) A power supply that complies with the Standard for Class 2 Power Units, UL 1310.

29.4 The transformer or power supply specified in [29.3](#) shall have a maximum output voltage both in normal use and in any single fault that does not exceed the limits in [Table 29.1](#).

Table 29.1
Transformer or power supply voltage limits

Voltage type	Maximum voltage
1. Sinusoidal, ac	15 V, rms
2. Nonsinusoidal, ac	21.2 V, peak
3. Pure dc ^a	30 V
^a DC output voltage generated by an electronic power unit is considered to be pure dc only if it is confirmed through test that the peak-to-peak value of ripple voltage is not more than 10 percent of the dc voltage.	

29.5 The Class 2 wiring to the low-voltage luminaire shall be stranded conductors having insulation not less than 0.013 inch (0.33 mm) thick, and shall be permanently attached to the unit.

29.6 The Class 2 wiring to the low-voltage luminaire shall be “W” rated. If the pump is rated for outdoor use, the cord or cable shall be suitable for outdoor use and be sunlight-resistant as applicable to outdoor cords.

29.7 Low-voltage cables internal to the pump shall comply with the Protection of Wiring requirements for Secondary Circuits specified in [SC1.1.3](#).

29.8 Pumps with low-voltage cord or cable connected luminaires are not prohibited from being provided with separable connectors intended for assembly and submersion in the field.

29.9 Pumps with low-voltage luminaires shall be marked with the lamp circuit voltage and the maximum total lamp wattage or current rating.

29.10 Low-voltage luminaires intended to be relamped shall be marked where visible during relamping with “Use ___ Volt, ___ type, ___ watts max lamps” or equivalent text.

PROTECTION AGAINST INJURY TO PERSONS

30 Sharp Edges

30.1 An edge, a projection, or a corner of an enclosure, an opening, a frame, a guard, a knob, a handle, or the like, shall be smooth and rounded, and not cause a risk of injury when contacted during normal use or maintenance.

31 Materials

31.1 The material of a part, such as an enclosure, a frame, a guard, or the like, the breakage of which may result in risk of injury to persons, shall have such properties as to meet the demand under expected loading conditions.

31.2 The requirement in [31.1](#) applies to those portions of a part adjacent to parts involving a risk of electric shock or moving parts considered to involve a risk of injury to persons.

31.3 The impact resistance of a part as mentioned in [31.1](#) shall be investigated in accordance with [31.4](#). The results are acceptable if the pump withstands the impact described in [31.4](#) without:

- a) Reduction of spacings below the minimum values;
- b) Making live parts accessible to contact;
- c) Breakage, cracking, rupture, or the like, such as to produce any adverse effect on the insulation; and
- d) Producing any other condition that would result in a risk of electric shock or injury to persons.

31.4 The pump is to be subjected to an impact of 5 foot-pounds (6.8 J) on any surface that is exposed to a blow 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 necessary to produce the specified impact. If the impact cannot be produced on the desired surface by means of a vertical drop, the sphere may be swung as a pendulum to produce a sidewall impact of 5 foot-pounds.

32 Stability

32.1 A fountain pump shall have means for mounting or shall be constructed so that it will be stable while resting on a surface that is tilted 15 degrees from the horizontal.

33 Polymeric Motor Supports

33.1 A polymeric part that supports a motor shall be subjected to the test described in [33.2](#) and [33.3](#). The results are acceptable if the motor remains securely mounted.

33.2 If 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 the unit. All bolts or screws that are intended to be field-mounted are to be tightened to the torque value specified in the instructions. If 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 to the upper manufacturing tolerance limit. The information on torque values is to be provided by the manufacturer for the testing of factory-assembled units.

33.3 The motor and parts are then to be placed for 300 hours 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 no less than 70°C (158°F). While in the oven, 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 operating conditions.

34 Parts Subject to Pressure

34.1 A pressure vessel having an inside diameter more than 6 inches (152 mm), subjected to a pressure more than 15 psig (102 kPa), and eligible to be covered by the National Board of Boiler and Pressure Vessel Inspectors shall be marked in accordance with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) for a working pressure no less than the pressure determined in accordance with [34.3](#).

34.2 A pressure vessel, because of its application, not covered by the scope of the inspection procedure of the ASME code shall be constructed so that it will comply with the requirements in [34.3](#).

34.3 A part or assembly that is subject to air or vapor pressure, including the vapor pressure in a vessel containing only a superheated fluid, during normal or abnormal operation shall withstand a pressure equal to the highest of the following that is applicable:

- a) Five times the pressure corresponding to the maximum setting of a pressure-reducing valve provided as part of the assembly, but no more than five times the marked maximum supply pressure from an external source and no more than five times the pressure setting of a pressure-relief device provided as part of the assembly.
- b) Five times the marked maximum supply pressure from an external source, unless the pressure is limited by a pressure-relief device in accordance with (a).
- c) Five times the pressure setting of a required pressure-relief device.
- d) Five times the maximum pressure that can be developed by an air compressor that is part of the assembly unless the pressure is limited by a pressure-relief device in accordance with (a).
- e) Five times the working pressure marked on the part.

Exception No. 1: This requirement does not apply to a section of a pressure system constructed of continuous tubing or of lengths of tubing connected by hard-soldered, brazed, or welded joints provided the wall thickness of tubing is no less than the value specified in [Table 34.1](#).

Exception No. 2: A pressure vessel bearing the ASME code inspection symbol – other than the UM symbol – need not comply provided the vessel is marked with a value of working pressure no less than that to which it is subjected during normal or abnormal operation.

Table 34.1
Wall thickness for copper and steel tubing

Outside diameter, inch (mm)		Minimum wall thickness, inch (mm)		Maximum pressure to which tubing is subjected					
				Seamless copper,		Butt-welded steel,		Seamless steel,	
				Psig	(MPa)	Psig	(MPa)	Psig	(MPa)
3/8 or smaller	(9.5)	0.016	(0.41)	500	(3.45)	600	(4.14)	1000	(6.90)
1/2	(12.7)	0.016	(0.41)	400	(2.76)	480	(3.31)	800	(5.52)
5/8	(15.9)	0.016	(0.41)	320	(2.21)	384	(2.65)	640	(4.42)

Table 34.1 Continued on Next Page

Table 34.1 Continued

Outside diameter, inch (mm)		Minimum wall thickness, inch (mm)		Maximum pressure to which tubing is subjected					
				Seamless copper,		Butt-welded steel,		Seamless steel,	
				Psig	(MPa)	Psig	(MPa)	Psig	(MPa)
5/8	(15.9)	0.021	(0.53)	420	(2.90)	504	(3.48)	840	(5.80)
3/4	(19.0)	0.021	(0.53)	360	(2.48)	432	(2.98)	720	(4.97)
3/4	(19.0)	0.025	(0.64)	420	(2.90)	504	(3.48)	840	(5.80)
1	(25.4)	0.021	(0.53)	260	(1.79)	312	(2.15)	520	(3.59)
1	(25.4)	0.025	(0.64)	320	(2.21)	384	(2.65)	640	(4.42)

34.4 If a test is required to determine whether a part complies with requirements in 34.3, 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. With the pressure-relief device bypassed or otherwise prevented from operating, the pressure is to be raised gradually to the specified test value, and is to be held at that value for 1 minute. The results are not acceptable if either sample bursts or leaks.

Exception: Leakage or rupture of a nonmetallic fluid-transfer line and its connections, or at a gasket is acceptable if repeated tests conducted with the media they are intended to contain show no evidence of presenting a risk of electric shock or injury to persons.

34.5 A part supported or actuated hydraulically that could result in a risk of injury to persons due to pressure loss shall comply with the requirement in 34.4 when tested at a pressure equal to five times the maximum pressure capable of being developed in the system.

35 Pressure-Relief Devices

35.1 A means for safely relieving pressure generated by an external source of heat shall be provided for a part that is subject to pressure as described in Parts Subject to Pressure, Section 34.

35.2 A pressure-relief device, fusible plug, a soldered joint, nonmetallic tubing, or other equivalent pressure-relief means may be used to comply with the requirements in 35.1.

35.3 A pressure-relief device is considered to be a pressure-actuated valve or rupture member constructed to relieve excessive pressures automatically.

35.4 There shall be no shut-off valve between the pressure-relief means and the parts that it is intended to protect.

35.5 A vessel having an inside diameter of more than 3 inches (76 mm) and subject to air or steam pressure generated or stored within the pump shall be protected by a pressure-relief device.

35.6 The start-to-discharge pressure setting of a pressure-relief device shall be no higher than the working pressure marked on the vessel. The discharge rate of the device shall be adequate to relieve the pressure.

35.7 A pressure-relief device shall:

- a) Be connected as close as possible to the pressure vessel or part of the system that it is intended to protect;

b) Be installed so that it is readily accessible for inspection and repair, and cannot be readily rendered inoperative so that it will not perform its intended function; and

c) Have its discharge opening located and directed so that:

1) Operation of the device will not deposit moisture on bare live parts or on insulation or components detrimentally affected by moisture and

2) The likelihood of scalding persons is reduced.

35.8 A pressure-relief device having an adjustable setting shall be judged on the basis of the maximum setting unless the adjusting means is reliably sealed at a lower setting.

35.9 A control that limits the pressure in a vessel required to have a pressure-relief device shall perform under rated load for 100,000 cycles of operation, and shall operate so that the pressure does not exceed 90 percent of the relief-device setting under any condition of normal operation.

35A Button or Coin Cell Batteries of Lithium Technologies

35A.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 pumps 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.

PERFORMANCE

36 Leakage Current Test

36.1 A cord-connected pump shall comply with leakage current requirements in the Standard for Leakage Current for Appliances, UL 101, and in [36.2](#).

36.2 A submersible pump is to be tested for leakage current while submersed in a tank filled with water. The top of the pump is to be at least 12 inches (305 mm) below the surface of the water during the test. The test tank shall be isolated from ground and the meter is to be connected between the grounding conductor and the grounded supply conductor of the flexible supply cord.

37 Leakage Current Test Following Humidity Conditioning

37.1 A pump as described in [36.1](#) shall comply with the requirements for leakage current in [36.1](#) following exposure for 48 hours to air having a relative humidity of 88 ± 2 percent at a temperature of $32 \pm 2^\circ\text{C}$ ($90 \pm 4^\circ\text{F}$).

37.2 To determine whether a pump complies with the requirement in [37.1](#), a sample of the pump is to be heated to a temperature just above 34°C (93°F) to reduce the risk of condensation of moisture during conditioning. The heated sample is to be placed in the humidity chamber and conditioned for 48 hours under the conditions specified in [37.1](#). Following the conditioning and while still in the chamber, the sample is to be tested unenergized as described in the Test Procedure specified in the Standard for Leakage Current for Appliances, UL 101. Either while the sample is still in the humidity chamber or immediately after it has been removed from the chamber, the sample is to be energized and tested as described in the Test Procedure specified in the Standard for Leakage Current for Appliances, UL 101. The test is to be discontinued when the leakage current stabilizes or decreases.

38 Starting Current Test

38.1 A pump shall be capable of starting and operating normally on a circuit protected by an ordinary (not time-delay) fuse having a current rating corresponding to that of the branch circuit to which the pump is intended to be connected.

Exception: A pump that meets all three of the following conditions:

- a) The construction of the pump or the nature of its use is such that the pump is likely to be used continually on the same branch circuit after installation;*
- b) The pump will start and operate normally on a circuit protected by a time-delay fuse; and*
- c) The pump is marked in accordance with [58.10](#).*

38.2 To determine compliance with the requirement in [38.1](#), the pump is to be started three times from a standstill without opening the fuse. The pump is to be at room temperature at the beginning of the test. The test is to be conducted at rated frequency and at the voltage specified in [39.1](#). Each start is to be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle in the case of an automatic pump – and the motor is to be allowed to come to rest between successive starts. Tripping of an overload protector provided as part of the pump, or opening of the fuse is not acceptable. Load conditions are to be in accordance with the requirements in [40.2.1](#).

39 Input Test

39.1 The ampere input to a pump shall not exceed 110 percent of the rated value when the pump is operated under the conditions of maximum normal load as described in [40.2.1](#) while connected to a branch circuit of maximum rated voltage and rated frequency. Maximum rated voltages are determined as follows:

- a) For a pump with a single DC voltage rating or a single AC rating not within the ranges of 110 – 120, 200 – 208, 220 – 240, 440 – 480, or 550 – 600 volts, rated voltage is that single voltage.
- b) For a pump with a single AC voltage rating that falls within one of the ranges given in (a), the rated voltage is considered to be the highest voltage in the range.
- c) For a pump marked with a range of voltages, the highest voltage in the marked range is to be considered as if it were a single voltage rating in (a) or (b).

39.2 A pump having a single frequency rating is to be tested at that frequency. A pump rated AC-DC, DC-60 hertz, or DC-25-60 hertz, is to be tested either on direct current or at 60 hertz, whichever results in the higher temperatures. A pump rated 25 – 60 hertz or 50 – 60 hertz is to be tested at 60 hertz.

40 Temperature Test

40.1 General

40.1.1 While loaded as described in [40.2.1](#), a pump shall not attain a temperature at any point sufficiently high to constitute a risk of fire, to damage any materials or parts used in the pump, or to exceed the temperatures specified in [Table 40.1](#).

40.1.2 All temperature values in [Table 40.1](#) are based on an assumed room ambient temperature of 25°C (77°F). The temperature test is to be conducted at any room temperature within the range of 10 – 40°C (50 – 104°F). If a test is conducted at an ambient temperature other than 25°C (77°F), an observed temperature shall be corrected as described in [40.1.3](#). A corrected temperature shall not exceed the maximum value specified in [Table 40.1](#).

Exception No. 1: For a submersible pump intended for use with unheated water, the ambient temperature shall be considered to be that of the water. The tank shall have enough capacity or be otherwise arranged so that the heat from the pump has a negligible effect on overall ambient water temperature.

Exception No. 2: A submersible sump or deep-well pump is to be tested with water maintained at a temperature in the range of 15 – 25°C (59 – 77°F).

Exception No. 3: A submersible pump intended for use with heated water or assigned a maximum water temperature by the manufacturer is to be tested at the maximum water temperature. The observed temperatures are not to exceed the temperature limits specified in [Table 40.1](#).

Table 40.1
Temperature limits

Materials and components	°C	(°F)
A. MOTORS		
1. Class 105 (A) insulation system on coil windings of an AC motor having a frame diameter 7 inches (178 mm) or less, not including a universal motor, and on a vibrator coil ^{a,b} :		
a. In an open motor and on a vibrator coil:		
Thermocouple method or resistance method	100	(212)
b. In a totally enclosed motor:		
Thermocouple method or resistance method	105	(221)
2. Class 105 (A) insulation systems on coil windings of an AC motor having a frame diameter of more than 7 inches, of a DC motor, and of a universal motor ^{a,b} :		
a. In an open motor:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b. In a totally enclosed motor:		
Thermocouple method	95	(203)

Table 40.1 Continued on Next Page

Table 40.1 Continued

Materials and components	°C	(°F)
Resistance method	105	(221)
3. Class 130 (B) insulation systems on coil windings of an AC motor having a frame diameter of 7 inches or less not including a universal motor ^{a,b} :		
a. In an open motor:		
Thermocouple or resistance method	120	(248)
b. In a totally enclosed motor:		
Thermocouple method or resistance method	125	(257)
4. Class 130 (B) insulation systems on coil windings of an AC motor having a frame diameter of more than 7 inches (178 mm), of a DC motor, and of a universal motor ^{a,b} :		
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 (F) insulation systems on coil windings of an AC motor having a frame diameter of 7 inches or less, not including a universal motor ^b :		
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 (F) insulation systems on coil windings of AC motors having a frame diameter of more than 7 inches (178 mm), and of a DC motor, and a universal motor ^b :		
a. In open motors		
Thermocouple method	135	(275)
Resistance method	145	(293)
b. In totally enclosed motors		
Thermocouple method	140	(284)
Resistance method	150	(302)
7. Class 180 (H) insulation systems on coil windings of AC motors having a frame diameter of 7 inches (178 mm) or less-not including a universal motor ^b :		
a. In open motors		
Thermocouple or resistance method	160	(320)
b. In totally enclosed motors		
Thermocouple or resistance method	165	(239)
8. Class 180 (H) insulation systems on coil windings of AC motors having a frame diameter of more than 7 inches (178 mm), of a DC motor, and a universal motor ^b :		
a. In open motors		
Thermocouple method	150	(302)
Resistance method	160	(320)
b. In totally enclosed motors		

Table 40.1 Continued on Next Page

Table 40.1 Continued

Materials and components	°C	(°F)
Thermocouple method	155	(311)
Resistance method	165	(329)
B. COMPONENTS		
1. Capacitors:		
a. Electrolytic ^c	65	(149)
b. Other types ^d	90	(194)
2. Fuses:		
a. Class G, J, L, T, and CC:		
Tube	125	(257)
Ferrule or blade	110	(230)
b. Others ^e	90	(194)
3. Relay, solenoid, and coils (except motor coil windings and transformers) with:		
a. Class 105 (A) insulated systems:		
Thermocouple method	90	(194)
Resistance method	110	(230)
b. Class 130 (B) insulation systems:		
Thermocouple method	110	(230)
Resistance method	120	(248)
4. Coils of a Class 2 transformer:		
a. Class 105 (A) insulation systems:		
Thermocouple method	90	(194)
Resistance method	110	(230)
b. Class 130 (B) insulation systems:		
Thermocouple method	110	(230)
Resistance method	120	(248)
C. CONDUCTORS		
1. Rubber- or thermoplastic-insulated wires and cords ^{e,f}	60	(140)
2. Copper		
a. Tinned or bare strands having:		
i) A diameter less than 0.015 inch (0.38 mm)	150	(302)
ii) A diameter of 0.015 inch or more	200	(392)
b. Plated with nickel, gold, silver, or a combination of these	250	(485)
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 is capable of resulting in a risk of fire or electric shock ^g :		
a. Laminated	125	(257)
b. Molded	150	(302)
3. Varnished-cloth insulation	85	(185)
E. SURFACES		

Table 40.1 Continued on Next Page

Table 40.1 Continued

Materials and components	°C	(°F)
1. A surface of flammable material upon which a pump is capable of being placed or mounted in service, and a surface that may be adjacent to the pump when it is so placed or mounted	90	(194)
2. Any point within a terminal box or wiring compartment of a permanently connected pump in which power-supply conductors are to be connected, including such conductors themselves, unless the pump is marked in accordance with 58.15	60	(140)
3. Wood or other flammable material, including the inside surface of the test enclosure and the surface supporting the pump	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 that is greater than the maximum temperature specified in this table complies with the intent of this requirement as long as the temperature, as measured by the resistance method, is not more than that specified. The temperature measured by means of a thermocouple is not prohibited from being greater than the specified value by: 1. 5°C (9°F) for Class 105 (A) insulation on coil windings of an AC motor having a diameter of 7 inches or less, open type; 2. 10°C (18°F) for Class 130 (B) insulation on coil windings of an AC motor having a diameter of 7 inches or less, open type; 3. 15°C (27°F) for Class 105 (A) insulation on coil windings of an AC motor having a diameter of more than 7 inches, open type; 4. 20°C (36°F) for Class 130 (B) insulation on coil windings of an AC motor having a diameter of more than 7 inches, open type. ^b This is the diameter measured in the plane of the laminations of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and similar parts, used solely for motor mounting, cooling, assembly, or connection. ^c For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum temperature rise on insulating material integral with the capacitor enclosure shall not be more than 90°C (194°F). ^d A capacitor that operates at a temperature of more than 90°C complies with the intent of this requirement when evaluated on the basis of its marked temperature limit. ^e These limitations do not apply to compounds and components that have been investigated and rated for use at higher temperatures. ^f A rubber-insulated conductor with a motor, a rubber-insulated motor lead, and a rubber-insulated conductor of a flexible cord entering a motor that is subjected to a higher temperature complies with the intent of this requirement when the conductor is provided with sleeving or a braid that has been investigated and rated for use at the higher temperature. This does not apply to thermoplastic-insulated wires or cords.		

40.1.3 Other than for a submersible pump intended for use with heated water and assigned a maximum temperature by the manufacturer, an observed temperature is to be corrected by addition [if the ambient temperature is lower than 25°C (77°F)] or subtraction (if the ambient temperature is higher than 25°C) of the difference between 25°C and the ambient temperature.

40.1.4 If a corrected temperature exceeds the required value specified in [Table 40.1](#), at the request of the manufacturer, the test may be repeated at an ambient temperature closer to 25°C (77°F).

40.1.5 A pump marked for use with heated water in accordance with [58.7](#) shall be tested while pumping water as close to the marked temperature as practicable. Heated water is considered as being water maintained at a temperature above 30°C (86°F).

40.1.6 For the temperature test, the voltage and frequency of the test circuit are to be as specified for the input test described in the Input Test, Section [39](#). A pump rated for use at more than one voltage or for a range of voltages and containing a tapped transformer or other means of adaption to different supply voltages is to be tested under the most severe combination of supply voltage and internal adjustment. The pump may be tested by connecting it in accordance with the manufacturer's instructions if:

- a) It is marked in accordance with [58.13](#) and [58.14](#) and

b) The means provided for adjusting for different supply voltages complies with the requirements for wiring terminals in Supply Connections, Section [16](#).

40.1.7 A thermocouple is to be used for determining the temperature of a coil or winding if it can be mounted without removal of encapsulating compound or the like:

a) On the integrally applied insulation of a coil without a wrap or

b) On the outer surface of a wrap that is no more than 1/32 inch (0.8 mm) thick and consists of cotton, paper, rayon, or the like.

The change-of-resistance method is to be used if the thermocouple measurement cannot be conducted in accordance with the foregoing. For a thermocouple-measured temperature of a motor coil as indicated in (A)(1) and (A)(3) of [Table 40.1](#), the thermocouple is to be mounted on the integrally applied insulation of the conductor.

40.1.8 Thermocouples are to consist of wires no larger than 24 AWG (0.21 mm²) and no smaller than 30 AWG (0.05 mm²). Whenever referee temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument are to be used.

40.1.9 The water around a submersible pump shall be still and not filled with entrained air, whirls, and the like, from recirculated discharge. The top of the pump shall be at least 12 inches (305 mm) below the surface of the water.

40.1.10 If a pump incorporates a cord reel for the power-supply cord, one-third of the length of the cord is to be unreeled for the temperature test.

40.1.11 A short length of rubber- or thermoplastic-insulated flexible cord exposed to a temperature higher than 60°C (140°F), such as at a terminal, may be used if supplementary heat-resistant insulation that is of dielectric strength and has temperature properties that have been determined to be acceptable is used on the individual conductors of the cord to reduce deterioration of the conductor insulation within the appliance.

40.1.12 Unless investigated and determined to be acceptable for the application, rubber and other material subject to abrasion and deterioration shall be removed from feet and other supports of a pump if absence of the material could result in the pump attaining higher temperatures.

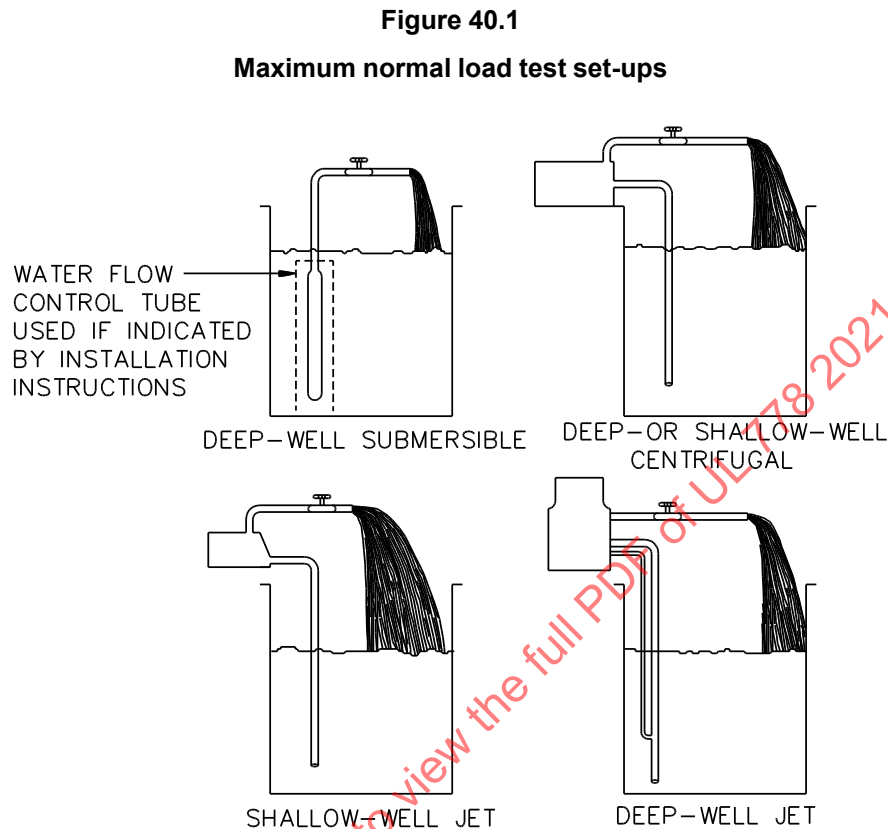
40.1.13 The temperature test is to be conducted using the maximum normal load, and is to be continued until thermal equilibrium is attained.

40.1.14 With reference to those tests that are to be 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 no less than 5-minute intervals, indicate no change.

40.2 Maximum normal load

40.2.1 In tests on a pump, maximum normal load is considered to be that load that approximates as closely as possible the most severe conditions of normal use. It is not a deliberate overload except as the conditions of actual use are likely to be somewhat more severe than the maximum load conditions recommended by the manufacturer of the pump. Test loads that have been found to be close approximations of the most severe conditions of normal use are described in [40.2.2](#) and [40.2.3](#) for some common types of pumps. Pumps having features not covered by these requirements are to be tested as

necessary to meet the intent of the requirements. Sump, sewage, and effluent pumps are to be tested while pumping water. Test setups for various types of pumps are illustrated in [Figure 40.1](#).



SB1940A

40.2.2 A pump is to be mounted as intended, considering any limitations of its use in the installation instructions provided in accordance with [61.1\(c\)](#). The test tank or sump is to be large enough to permit compliance with Exception No. 1 to [40.1.2](#) and [40.1.9](#). The pump is to be operated in the intended manner with the valve located in the water outlet pipe adjusted so that the maximum current is drawn by the pump.

Exception No. 1: For a centrifugal pump other than a sump pump, the water static discharge head distance is to be as short as possible unless the pump is marked for some other discharge head distance, in which case the marked distance is to be used.

Exception No. 2: For a sump pump, the water lift distance is to be 4 – 10 feet (1.2 – 3 m), and is to be adjusted to produce the highest electrical input.

40.2.3 A pump that is intended to circulate heated water – see [58.7](#) – is to be tested installed in a pipe loop attached to a heating unit adjusted to maintain the maximum water temperature recommended by the manufacturer.

41 Dielectric Voltage-Withstand Test

41.1 General

41.1.1 A pump shall withstand for 1 minute without electrical breakdown the application of a DC potential or an AC potential at a frequency within the range of 40 to 70 Hz:

- a) Between live parts and grounded dead metal and
 - b) Between the terminals of a capacitor used for radio interference elimination or arc suppression.
- The test potential shall be as shown in [Table 41.1](#).

Table 41.1
Dielectric voltage withstand voltages

Machine voltage rating, V	Test potential V AC	Test potential V DC
A nonsubmersible pump rated no more than 250 volts, and no more than 1/2 horsepower (373 watt output)	1000	1400
A nonsubmersible pump rated more than 250 volts, or more than 1/2 horsepower	$1000 + 2V^a$	$1400 + 2.8V^a$
A submersible pump	$1000 + 2V^a$	$1400 + 2.8V^a$
^a Maximum marked voltage.		

41.1.2 The required test potential may be obtained from any convenient source of sufficient capacity at least 500 volt-amperes capable of maintaining the potential at the required test value except during breakdown. The voltage of the source is to be continuously variable.

Exception: A 500 volt-ampere or larger capacity transformer need not be used if the transformer is provided with a voltmeter to directly measure the applied output potential.

41.1.3 In the case of a DC pump, the test potential is to be direct current.

41.2 Secondary circuits

41.2.1 Secondary circuits shall withstand for 60 seconds without electrical breakdown the application of a test potential in accordance with [41.2.2](#).

- a) Between primary and secondary circuits,
- b) Between secondary circuits and grounded metal with all frame-connected components in place, and
- c) Between secondary circuits supplied from separate transformer windings with common connections disconnected and frame connections in place.

The pump is to be at its maximum normal operating temperature during the test. A DC potential or an AC potential at a frequency within the range of 40 to 70 Hz is to be used for testing.

41.2.2 The test potential for a secondary circuit shall be as shown in [Table 41.2](#).

Table 41.2
Dielectric voltage withstand voltages for Secondary circuits

Machine voltage rating, V	Test potential V AC	Test potential V DC
A secondary circuit operates at 50 volts or less	500	700
A secondary circuit operates at 51 – 250 volts	1000	1400
A secondary circuit operates at 251 – 600 volts	$1000 + 2V^a$	$1400 + 2.8V^a$
^a Maximum operating voltage		

42 Oil Dielectric Voltage-Withstand Test

42.1 After conditioning in accordance with [42.2](#), oil in contact with live parts or motor-coil insulation that is used for heat transfer in a pump shall comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#).

42.2 One pint (0.42 L) of the oil is to be heated to $90 \pm 1^\circ\text{C}$ ($194 \pm 2^\circ\text{F}$), and while hot, two electrodes of 12 AWG (3.3 mm^2) solid copper wire, with the insulation removed and tips flat, are to be inserted in the oil with the electrode tips placed 1/16 inch (1.6 mm) apart. The test potential is to be applied between the electrodes in accordance with the requirements in [41.1.1](#).

43 Resistance to Moisture Test

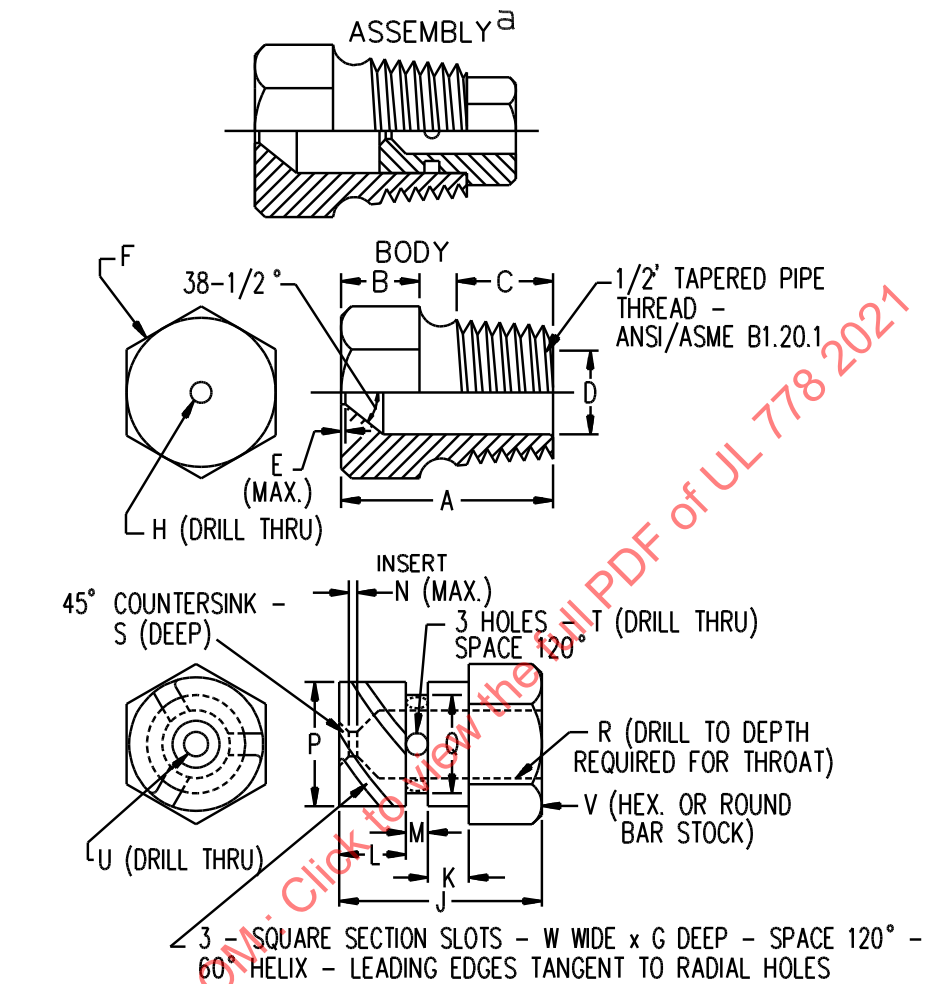
43.1 A nonsubmersible pump or control intended for outdoor use shall be tested as described in [43.2](#) – [43.4](#).

43.2 The pump is to be mounted as intended and is to be subjected to 4 hours of a water spray adjusted to be the equivalent of a beating rain. The water to be used for the test shall have its resistivity adjusted before the test is started to 3500 ohm-centimeters ± 5 percent when measured at 25°C (77°F). At the conclusion of the test, the resistivity of the water shall be no less than 3200 ohm-centimeters or more than 3800 ohm-centimeters at 25°C .

43.3 A pump intended for outdoor use is to be subjected for 4 hours to a simulated rain by means of the apparatus illustrated in [Figure 43.1](#) and [Figure 43.2](#). The spray is to be applied to the enclosure at an angle of 45 degrees to the vertical, and adjusted to be approximately the equivalent of a beating rain, as maintained by keeping all nozzle pressure at 5 psi (34.5 kPa). The pump under test is to be in a normal position, but oriented so that the likelihood of water entering the enclosure into or onto electrical components and insulation is maximized.

43.4 Upon completion of the test, the leakage-current test for a cord-connected pump, or the insulation resistance test for a permanently installed pump, and the dielectric voltage-withstand test are to be repeated. The interior of the pump is to be inspected for obvious wetting of live parts or insulation.

Figure 43.2
Rain-test spray head



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.

44 Submersion Test

44.1 A submersible pump, after being operated for 30 days as described in [44.2](#), shall:

- a) Perform acceptably;
- b) Comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#), in a repeated dielectric voltage-withstand test;
- c) Comply with the leakage-current requirements in the Leakage Current Test, Section [36](#), if cord-connected, or the insulation resistance requirements in the Insulation Resistance Test, Section [46](#), if permanently installed; and
- d) Not show evidence of the entrance of liquid into the interior of the motor or other electrical part such that it could contact live parts or film-coated wire.

44.2 During conditioning, the pump is to be cycled on and off continuously for 30 days in water at 18°C – 30°C (64°F – 86°F). The on time is to be long enough for the motor windings to attain a temperature of at least 80 percent of the value measured during the temperature test, and the off cycle is to be long enough for the windings to cool to 30°C (86°F) or less. The pump is to be operated at maximum normal load as described in [40.2.1](#), and is to be submerged so that the top of the pump is at least 12 inches (305 mm) below the surface of the water.

45 Flooding Test

45.1 A nonsubmersible pump, after being operated for 1 hour with any field-connected inlet or discharge fitting for hose or flexible tubing loosened to simulate a fault or loose connection, shall comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#), and in the Leakage Current Test, Section [36](#), or the Insulation Resistance Test, Section [46](#), as applicable.

45.2 While conducting the test described in [45.1](#), the pump is to be in a normal position but oriented to be most likely to cause entrance of water into, or on, electrical components and insulation.

45.3 The deterioration or breakdown of a component, such as a timer switch, a float- or pressure-operated switch, a hose, flexible tubing, a gasket, a boot, a seal, a diaphragm, or the like, shall not result in a risk of electric shock due to:

- a) Current leakage,
- b) Insulation breakdown, or
- c) Obvious wetting of any electrical component resulting from such deterioration or breakdown.

Exception: A part that has been investigated and determined to be acceptable for the purpose. See Sections [47](#), Test for Deterioration of Parts Subject to Flexing, [48](#), Test for Reliability of Parts Not Subject to Flexing, and [53](#), Abnormal Operation Test.

45.4 Test procedures for the requirements in [45.3](#) shall be those described in the Test for Deterioration of Parts Subject to Flexing, Section [47](#), and the Test for Reliability of Parts Not Subject to Flexing, Section [48](#). See the Abnormal Operation Test, Section [53](#).

45.5 Obvious wetting, as used in [45.3](#)(c), means wetting by a stream, spray, or dripping of water that will obviously be repeated during each flooding. Obvious wetting is not meant to include wetting by random drops of water that may not be regularly repeated during subsequent flooding.

46 Insulation Resistance Test

46.1 Following the temperature test and the simulated rain, submersion, or flooding, as appropriate, a pump intended for permanent installation shall have an insulation resistance of at least 50,000 ohms between current-carrying parts and noncurrent-carrying parts.

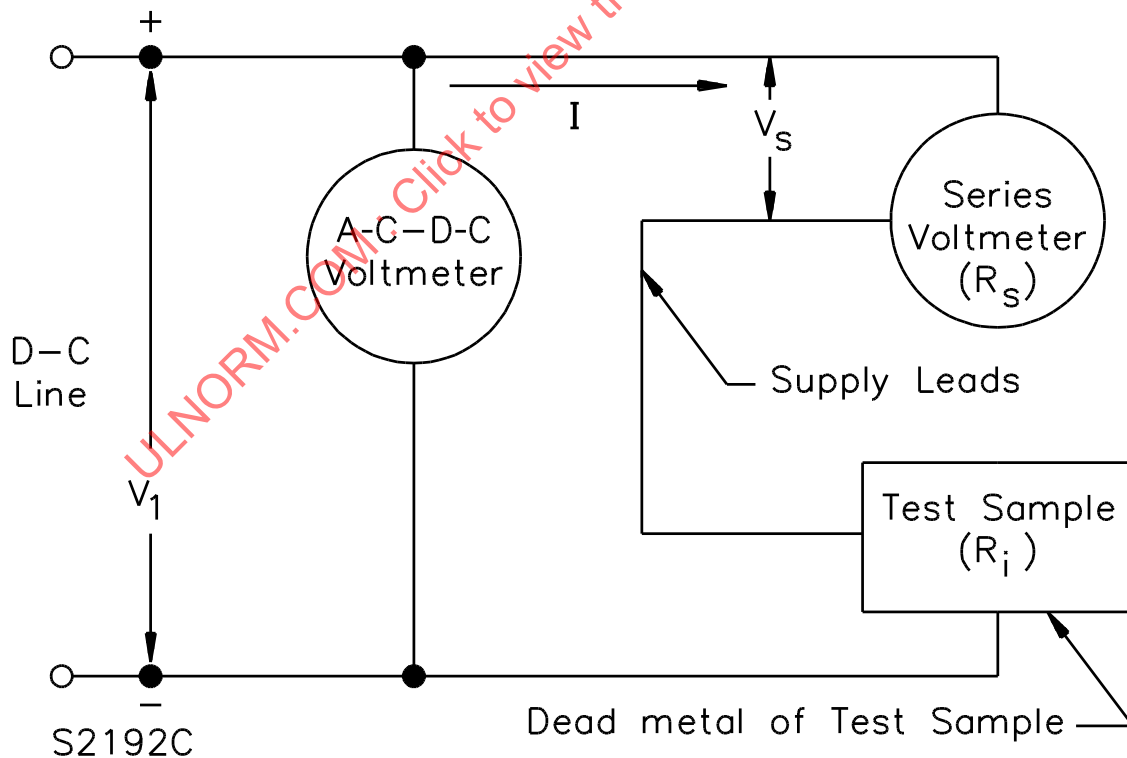
46.2 Insulation resistance is to be measured by applying a direct-current potential of 125 volts between live parts and the enclosure and other exposed dead metal parts, using two voltmeters – one voltmeter being connected across the supply line and the other connected in series with one of the leads to the pump being tested. See [Figure 46.1](#). Designating the reading of the line voltage as V_1 , the reading of the other voltmeter as V_s , and the resistance of the latter as R_s , the insulation resistance is to be calculated by the formula:

$$\text{Insulation Resistance} = \frac{(V_1 - V_s) R_s}{V_s}$$

Exception: Self-contained laboratory grade instrumentation that produces equivalent results, such as a megohmmeter with an open circuit output of 500 volts DC, is not prohibited from being used in place of the two-voltmeter circuit shown in [Figure 46.1](#).

Figure 46.1

Two-voltmeter method of measuring insulation resistance



47 Test for Deterioration of Parts Subject to Flexing

47.1 To determine whether a pump complies with the requirements in [45.3](#) with regard to parts subject to flexing, the deterioration of a part made of rubber, plastic, or similar material shall be simulated by operating the pump with the part completely removed.

Exception No. 1: Infrequent motion of small amplitude, such as that encountered during normal operation of a diaphragm covering a pressure-operated switch, is not considered to constitute flexing.

Exception No. 2: A part that has been investigated to determine that flexing does not result in a risk of electric shock need not be subjected to this test.

47.2 While being tested as described in [47.1](#), the leakage current of a cord-connected pump, when determined by the method described in the Leakage Current Test, Section [36](#), shall not exceed 5.0 milliamperes.

47.3 After being tested in accordance with [47.1](#), a permanently-installed pump shall:

- a) Have an insulation resistance between live parts and exposed dead metal parts of at least 50,000 ohms, measured as described in the Insulation Resistance Test, Section [46](#), and
- b) Comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#).

48 Test for Reliability of Parts Not Subject to Flexing

48.1 To determine acceptability in accordance with the Exception to [45.3](#), a material, used for a gasket, a diaphragm, a seal, or the like shall have the physical properties as specified in [Table 48.1](#) before and after the accelerated aging specified in [Table 48.2](#). The material shall not harden, deform, melt, or otherwise deteriorate to a degree that will adversely affect the sealing properties.

Exception No. 1: A material of a component not under compression need not be subjected to the compression set requirements.

Exception No. 2: A material that has been investigated in accordance with [48.5](#) may have physical properties other than as specified in [48.1](#).

Exception No. 3: A noncomposite material that has been found to comply with the requirements in Table 4.1 of the Standard for Gaskets and Seals, UL 157, and that complies with the minimum acceptable elongation, tensile strength, set, and compression set after aging as specified in [Table 48.1](#) is considered in compliance with these requirements.

Exception No. 4: Gaskets and seals used only for the environmental rating of the pump that comply with the requirements for gaskets in the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E are considered in compliance with this requirement.

Exception No. 5: Grease type gaskets and seals used only for the environmental rating of the pump that comply with the requirements in [48.6](#).

Table 48.1
Physical properties for gaskets and seals

Physical properties	Elastomers (neoprene, rubber, ethylene, propylene and the like),		Nonelastomers (polyvinyl chloride, and the like, excluding cork, fiber, and similar materials),	
	Before conditioning	After conditioning	Before conditioning	After conditioning
Minimum acceptable elongation ^a	—	60 percent of original	—	60 percent of original
Minimum acceptable tensile strength	—	60 percent of original	—	60 percent of original
Maximum acceptable set ^b	1/4 inch (6.4 mm)	—	Not specified	—
Maximum acceptable compression set ^c	15 percent	—	Not specified	—

^a Percent increase in distance between gauge marks at break compared to initial distance of 1 inch (25.4 mm). For example, a distance at break of 3.5 inches (89 mm) is 250 percent elongation.

^b Difference between 1 inch and final distance when the specimen is stretched so that gauge marks initially 1 inch apart are 2 inches (50.4 mm) apart, held for 2 minutes, and measured 2 minutes after release.

^c Percent set measured after Type 1 button specimens are compressed by one-fourth of original thickness, unless the construction of the gasket joint effectively limits initial compression to less than one-third of original, in which case actual compression will be used, and heat conditioned for 22 ± ½ hours at 70°C (158°F) or 10°C (18°F) higher than normal operating temperature, whichever is higher, following the procedure in Method B of the Standard Test Methods for Rubber Property – Compression Set, ASTM D395.

48.2 A gasket of material other than those specified in [Table 48.1](#), such as bonded cork or impregnated fiber, that is not known to be reliable, shall be investigated in accordance with the requirements for tensile strength in the Standard for Gaskets and Seals, UL 157. Test samples shall be taken from sheets in both the transverse and longitudinal directions. Absorptive materials, such as cork or fiber shall not be used where they are capable of contacting a live part.

48.3 A boot shall comply with requirements for nonelastomeric material, and a diaphragm that is compressed at the circumference shall comply with requirements for elastomeric material.

48.4 The temperatures specified in [Table 48.2](#) correspond to the maximum temperature rise measured on the material during the Temperature Test, Section [40](#).

48.5 To determine acceptability in accordance with Exception No. 2 to [48.1](#), a gasket, a diaphragm, or a seal is to be subjected to accelerated-aging conditions specified in [Table 48.2](#). The gasket, diaphragm, or seal is then to be installed in the associated pump. It is not prohibited to subject the entire pump assembly to the accelerated-aging conditions. When an entire pump assembly is subjected to the accelerated-aging test, the gasket, diaphragm, or seal temperature shall be monitored and maintained at the values indicated in [Table 48.2](#). A submersible pump is then to be subjected to the Submersion Test, Section [44](#), for 60 days. All other pumps shall be subjected to a hydrostatic pressure test. The 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 to a value of 1.2 times the maximum pressure 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.

48.6 Grease type seal materials used for environmental ratings of pumps shall have the following parameters:

- a) National Lubricating Grease Institute (NLGI) Grade 2 or 3;
- b) Dropping Point per the Standard Test Method for Dropping Point of Lubricating Grease Over Wide Temperature Range, ASTM D2265 50C higher than the maximum service temperature of the material;

c) The Standard Test Methods for Cone Penetration of Lubricating Grease, ASTM D217 percent change from 60 strokes to 100000, no more than 30%;

d) The Standard Test Method for Determination of Corrosion-Preventive Properties of Lubricating Greases Under Dynamic Wet Conditions (Emcor Test), ASTM D6138 (EMCOR Corrosion) rating 0, 1, or 2; and

e) The Standard Test Method for Determining the Water Washout Characteristics of Lubricating Greases, ASTM D1264 water washout rating less no more than 5%.

Table 48.2
Accelerated-aging conditions

Measured temperature rise, °C (°F)		Test program ^a	
		Non-elastomers, °C (°F)	Elastomers, °C (°F)
35 or less	(63 or less)	168 hours at 87 (189) ^c	70 hours at 100 (212) ^{b,c}
36 – 50	(64.8 – 90)	240 hours at 100 (212) ^c	168 hours at 100 (212) ^{b,c}
51 – 55	(91.8 – 99)	168 hours at 113 (235) ^c	168 hours at 113 (235) ^c
56 – 65	(100.8 – 117)	168 hours at 121 (250) ^c	168 hours at 121 (250) ^c
		or 1440 hours at 97 (207) ^c	
66 – 80	(118.8 – 144)	168 hours at 136 (277) ^c	168 hours at 136 (277) ^c
81 – 90	(145.8 – 162)	1440 hours at 121 (250) ^c	1440 hours at 123 (253) ^c
			or 360 hours at 143 (289) ^c
91 – 100	(163.8 – 180)	1440 hours at 131 (268) ^c	1440 hours at 133 (271) ^c
			or 360 hours at 153 (307) ^c
101 – 110	(181.8 – 198)	1440 hours at 141 (286) ^c	1440 hours at 143 (289) ^c
			or 360 hours at 163 (325) ^c
110 – 120	(199.8 – 216)	1440 hours at 150 (302) ^c	1440 hours at 153 (307) ^c
			or

Table 48.2 Continued on Next Page

Table 48.2 Continued

Measured temperature rise, °C (°F)	Test program ^a	
	Non-elastomers, °C (°F)	Elastomers, °C (°F)
		360 hours at 173 (343) ^c
^a Temperatures specified have a tolerance of $\pm 1.0^{\circ}\text{C}$ ($\pm 1.8^{\circ}\text{F}$), except where otherwise noted. The test temperature is not prohibited from being reduced by 10°C (18°F) when the test duration is doubled. For example, a rubber gasket that measured 60°C (140°F) in the pump is not prohibited from being tested at 100°C (212°F) for 70 hours or at 90°C (194°F) for 140 hours. ^b Specified temperature has a tolerance of $\pm 2^{\circ}\text{C}$ ($\pm 3.6^{\circ}\text{F}$). ^c An air-circulating oven should be used for all temperatures.		

49 Metallic Coating Thickness Test

49.1 The method of determining the thickness of a zinc coating as required by Protection Against Corrosion, Section 14, shall be as described in 49.2 – 49.9.

49.2 The solution used is to be made up of 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 in distilled water. The sulfuric acid is equivalent to 27 milliliters per liter of concentrated sulfuric acid, specific gravity 1.84, containing 96 percent H_2SO_4 .

49.3 The test solution is to be placed in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube with an inside bore of 0.025 inch (0.635 mm) and a length of 5.5 inches (139.7 mm). 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 then 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.

49.4 The sample and the test solution are to be kept in the test room long enough to acquire the temperature of the room, and this temperature is to be recorded. The test is to be conducted at a room temperature between 21.1 and 32.2°C (70 and 90°F).

49.5 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 acceptable solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be taken to avoid contact of the cleaned surface with the hands or any foreign material.

49.6 The sample to be tested is to be supported between 0.7 and 1 inch (17.8 and 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 is to be inclined about 45 degrees from horizontal.

49.7 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 stopwatch until the dropping solution dissolves the protective metallic coating, exposing the base metal. The end of the timing period is the first appearance of the base metal, recognizable by a change in color at that point.

49.8 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 are likely to have thin coatings.

49.9 To calculate the thickness of the coating, the appropriate thickness factor is to be selected from [Table 49.1](#), considering the temperature at which the test was conducted. This factor is then to be multiplied by the time in seconds required to expose base metal during the test.

Table 49.1
Metallic-coating-thickness-test factors

Temperature,		Thickness factors, 0.00001 inch (0.0003 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

50 Switches and Controls Test

50.1 A switch or other device that controls a pump motor, unless previously judged acceptable for the application or unless interlocked so that it will never break the locked-rotor motor current, shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the pump. There shall be no electrical or mechanical malfunction of the control device, nor undue pitting or burning of the contacts.

50.2 In a test to determine whether a switch or other control device performs acceptably in the overload test, the pump is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage – see [39.1](#). The rotor of the motor is to be locked. During the test, exposed dead metal parts of the pump are to be connected to ground through a 3-ampere fuse of the appropriate voltage rating, and the connection is to be such that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit.

50.3 If the pump is intended for use on direct current or on direct current as well as alternating current, the exposed dead metal parts of the pump are to be connected so as to be positive with regard to a single-pole current-rupturing device. The device under test is to be operated at a rate of no more than 10 cycles per minute. The performance of the switch or other control device is unacceptable if the fuse in the grounding circuit opens during the test.

Exception: The device under test may be cycled at a faster rate than that specified if agreeable to all concerned.

50.4 To determine that a horsepower-rated switch or other control device is acceptable for the application, it will be necessary to determine the horsepower rating of the motor intended to be controlled. Reference is to be made to [Table 50.1](#) and [Table 50.2](#) for this purpose. The switch ratings shall at least equal the full-load current or horsepower rating of the pump, whichever represents the higher current.

Table 50.1
Full-load motor-running currents in amperes corresponding to various AC horsepower ratings

Horsepower	110 – 120 volts			220 – 240 volts ^a			440 – 480 volts			550 – 600 volts		
	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase
1/10	3.0	—	—	1.5	—	—	—	—	—	—	—	—
1/8	3.8	—	—	1.9	—	—	—	—	—	—	—	—
1/6	4.4	—	—	2.2	—	—	—	—	—	—	—	—
1/4	5.8	—	—	2.9	—	—	—	—	—	—	—	—
1/3	7.2	—	—	3.6	—	—	—	—	—	—	—	—
1/2	9.8	4.0	4.0	4.9	2.0	2.0	2.5	1.0	1.0	2.0	0.8	0.8
3/4	13.8	4.8	5.6	6.9	2.4	2.8	3.5	1.2	1.4	2.8	1.0	1.1
1	16.0	6.4	7.2	8.0	3.2	3.6	4.0	1.6	1.8	3.2	1.3	1.4
1-1/2	20.0	9.0	10.4	10.0	4.5	5.2	5.0	2.3	2.6	4.0	1.8	2.1
2	24.0	11.8	13.6	12.0	5.9	6.8	6.0	3.0	3.4	4.8	2.4	2.7
3	34.0	16.6	19.2	17.0	8.3	9.6	8.5	4.2	4.8	6.8	3.3	3.9
5	56.0	26.4	30.4	28.0	13.2	15.2	14.0	6.6	7.6	11.2	5.3	6.1
7-1/2	80.0	38.0	44.0	40.0	19.0	22.0	21.0	9.0	11.0	16.0	8.0	9.0
10	100.0	48.0	56.0	50.0	24.0	28.0	26.0	12.0	14.0	20.0	10.0	11.0
15	135.0	72.0	84.0	68.0	36.0	42.0	34.0	18.0	21.0	27.0	14.0	17.0

NOTE – A motor for a submersible pump may have a higher full-load running current value, in which case the marked value shall be used.

^a To obtain full-load currents for 200- and 208-volt motors, increase corresponding 220 – 240 volt ratings by 15 and 10 percent, respectively.

Table 50.2
Full-load motor-running currents in amperes corresponding to various DC horsepower ratings

Horsepower	110 – 120 volts	220 – 240 volts	550 – 600 volts
1/10	2.0	1.0	—
1/8	2.2	1.1	—
1/6	2.4	1.2	—
1/4	2.9	1.5	—
1/3	3.6	1.6	—

Table 50.2 Continued on Next Page

Table 50.2 Continued

Horsepower	110 – 120 volts	220 – 240 volts	550 – 600 volts
1/2	5.2	2.6	–
3/4	7.4	3.7	1.6
1	9.4	4.7	2.0
1-1/2	13.2	6.6	2.7
2	17.0	8.5	3.6
3	25.0	12.2	5.2
5	40.0	20.0	8.2
7-1/2	58.0	29.0	12.0
10	76.0	38.0	16.0
15	112.0	55.0	23.0

51 Strain Relief Tests

51.1 When tested in accordance with [51.2](#), the strain-relief means provided on a flexible cord is to withstand for 1 minute, without displacement of the cord, a direct force of 35 pounds (156 N) applied to the cord with the connections within the pump severed.

51.2 A 35 pound (15.9 kg) weight is to be suspended from the cord and supported by the pump so that the strain-relief means is stressed from any angle that the construction of the pump permits. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections or the watertight seal is damaged.

51.3 Strain relief at the entrance of a cord or cable of a contractor-type pump shall support the pump for 1 minute without damage to the seal or transmission of stress to the internal connections.

51.4 Strain relief at the entrance of deep-well cable to a deep-well, submersible-type pump shall withstand a 35 pound (156 N) force applied to each conductor for 1 minute without damage to the seal or transmission of stress to the internal connections. The test shall be conducted on each conductor of a twisted-singles construction and on the complete cable of the integral parallel conductor type.

52 Operation Test

52.1 Operation of a pump as described in [52.2](#) shall not increase the risk of fire, electric shock, or injury to persons.

52.2 With reference to [52.1](#), an as-received sample of the pump is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated in accordance with the manufacturer's instructions with regard to the intended uses of the pump, including maintenance and cleaning recommended by the manufacturer and lack of such maintenance and cleaning, and with all accessories recommended by the manufacturer for use with the pump. The pump is to be manipulated as it would be in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected. The pump is to be operated only for the length of time, or number of cycles needed to determine the appropriateness of the manufacturer's instructions.

53 Abnormal Operation Test

53.1 Dry operation

53.1.1 A pump that can be operated dry shall not create a risk of fire or electric shock when operated and tested in accordance with [53.1.3](#).

53.1.2 It shall be assumed that a pump can be operated dry if it does not incorporate a device that will open the supply circuit when water or water pressure falls below operating limits.

53.1.3 To determine if a pump complies with the requirement in [53.1.1](#), it is to be installed in a manner representative of typical operation and allowed to pump from a limited water supply until all water capable of being removed is gone. Operation is to continue for 7 hours without adding water. After cooling to ambient temperature, the pump is to be operated for 1 hour, pumping water normally, unless it is damaged so that water cannot reach the impeller. The pump shall comply with the requirements in [53.1.4](#) and [53.1.5](#). In addition, an inspection of the pump shall indicate that no water has entered the enclosure where it may contact an uninsulated live part or film-coated wiring.

Exception: A pump provided with a water-level switch, or a pressure-sensitive control so that the pump cannot operate with the water intake supply interrupted need not be subjected to this test.

53.1.4 While being tested as described in [53.1.3](#), the leakage current of a cord-connected pump, when determined by the method described in the Leakage Current Test, Section [36](#), shall not exceed 5.0 milliamperes. The pump shall also comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#), after the test.

53.1.5 After being tested as described in [53.1.3](#), a permanently-installed pump shall:

- a) Have an insulation resistance between live parts and exposed dead-metal parts of at least 50,000 ohms, measured as described in the Insulation Resistance Test, Section [46](#), and
- b) Comply with the requirements in the Dielectric Voltage-Withstand Test, Section [41](#).

53.2 Burnout test

53.2.1 A pump employing a solenoid or water valve shall be subjected to the following conditions without emission of flame or molten metal from the enclosure and without otherwise becoming a fire hazard:

- a) A solenoid or a water valve shall be capable of being operated continuously without water and
- b) A solenoid or water valve shall be energized having the plunger of a solenoid or valve blocked in the open position with water in the system.

53.2.2 The pump shall be covered with a double layer of white cheesecloth and supported on a softwood surface covered with a double layer of white tissue paper. The test shall be continued for 7 hours unless the ultimate results occur sooner. The power-supply circuit shall include a fuse of the maximum current rating that is accommodated by the fuse holder of the branch circuit to which the pump would normally be connected, but not less than 20 amperes. During the test, exposed dead-metal parts of the pump are to be connected to ground through a 3-ampere, nontime-delay fuse.

53.3 Component breakdown test

53.3.1 A product shall not present a risk of fire or electric shock when subjected to the following to the test in [53.3.6](#). The Dielectric Voltage-Withstand Test, Section [41](#), shall follow each abnormal test.

53.3.1.1 Components in secondary circuits shall be subjected to the Component Breakdown Test, [53.3](#). For switch mode power supplies, shall additionally include components on the primary and secondary side of the transformer.

Exception: The test is not required:

- a) *If circuit analysis indicates that no other component or portion of the circuit will be seriously overloaded as a result of the assumed open circuiting or short circuiting of another component.*
- b) *For components in Class 2 or LPS circuits mounted on a surface with a minimum flammability of V-1.*
- c) *For components in Class 2, LPS, or Limited Voltage Limited Energy circuits that are provided with enclosures complying with Fire and Electrical Enclosures, Section [10](#).*
- d) *For protective Impedance secondary circuits.*
- e) *For components complying with requirements applicable to the component.*
- f) *For components whose failure may result in an increased risk of fire or electric shock and that have previously been investigated and found suitable for the application.*

53.3.2 A risk of fire or electric shock is considered to exist if any of the following occur:

- a) Opening of the grounding fuse;
- b) Charring of cheesecloth; and
- c) Emission of flame or molten material from the pump enclosure.

53.3.3 Each test is to be conducted on a separate sample unless those concerned agree that more than one test can be conducted on the same sample.

53.3.4 Dead metal is to be connected to ground through a 3-ampere, nontime-delay fuse.

53.3.5 The appliance is to be draped with a double layer of cheesecloth conforming to the outline of the product.

53.3.6 The components in the product (such as diodes, resistors, transistors, capacitors, and similar components) are to be shorted or opened, one at a time. The product is to be connected to the maximum test voltage and operated until ultimate conditions are observed, or for 4 hours when cycling of an automatically-reset protector occurs. This test need not be conducted for a component in a low-voltage circuit.

53.4 Low-voltage luminaire dry operation test

53.4.1 The product shall not present a risk of fire when subjected to the test specified in [53.4.2](#). A risk of fire is considered to exist if any of the following occur:

- a) Charring of the cheesecloth;
- b) Charring of the tissue paper;
- c) Emission of flame or molten material from the luminaire enclosure.

53.4.2 The pump shall be operated submerged in the intended manner with the provided luminaires operated dry. The luminaires shall be covered with a double layer of white cheesecloth and supported on a softwood surface covered with a double layer of white tissue paper. The test shall be continued for 7 hours unless the ultimate results occur sooner.

53.5 Transformer overload test

53.5.1 Three transformers are to be placed on a tissue-paper covered soft wood surface and each covered with a layer of cheesecloth. A one-ampere cartridge fuse is to be connected in series from the core and the shield, if applicable, of each transformer to ground. Each transformer is to be protected by an overcurrent device. The device is to be the same as provided in the unit to protect the transformer, or if none is provided, is to be a branch circuit type as specified in [39.1](#). With all secondaries simultaneously short-circuited, each transformer is to be energized as for 7 hours or until ultimate results occur. Results are in compliance when:

- a) The ground fuse remains intact;
- b) Each transformer withstands the potential specified in the Dielectric Voltage-Withstand Test, Section [55](#), while still warm from this test; and
- c) There is no ignition of the cheesecloth or tissue paper.

Exception: The test may be conducted in a manner similar to that described in [53.5.1](#) but with the transformer(s) installed in the end product.

53.5.2 Following each shorted-trace test, the device shall comply with the Dielectric Voltage-Withstand Test, Section [41](#).

53.5.3 Operation of an overcurrent protection device integral to the equipment under test, before any abnormal condition results is acceptable. When a wire or a printed wiring board trace opens, the gap is to be electrically shorted and the test continued. This applies to each occurrence. When the circuit is interrupted by the opening of a component, the test is to be repeated twice, using new components as necessary.

53.5.4 A sample of the equipment employing the printed wiring board is to be wired as intended to an electrical supply circuit sized and protected to simulate end-use conditions.

53.5.5 A 3-ampere fuse is to be connected between the supply circuit pole least likely to arc to ground, and the outer enclosure and grounded or exposed dead metal parts.

53.5.6 The equipment is to be placed on a white-tissue-paper covered softwood surface. A single layer of cheesecloth is to be draped loosely over the entire enclosure.

53.6 Switch mode power supply overload test

53.6.1 Each output winding, or section of a tapped winding, is overloaded in turn, one at a time, while the other windings are kept loaded or unloaded, whichever load conditions of normal use is the least favorable.

53.6.2 Overloading is carried out by connecting a variable resistor (or an electronic load) across the power supply output. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 minute to maintain the applicable overload. No further readjustments are then permitted.

53.6.3 For this test, any protective devices such as a fuse, manual reset circuit protector, thermal protector, etc. is allowed to remain in the circuit.

53.6.4 If overcurrent protection is provided by an overcurrent protection device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 hr. If this value cannot be derived from the specification, it is to be established by test.

53.6.5 If no overcurrent protection is provided, the maximum overload is the maximum power output obtainable from the power supply.

53.6.6 In case of voltage foldback, the overload is to be slowly increased to the point which causes the output voltage to collapse. The overload is then established at the point where the output voltage recovered and held for the duration of the test.

53.6.7 The duration of the test is to be for 7 hours or until ultimate results are reached. At the conclusion of the test, there shall be no charring or burning of electrical insulation, no opening of any protective device or any circuit component.

53.7 Secondary circuits tests

53.7.1 General

53.7.1.1 Unless otherwise specified, the test measurements are to be made as follows:

- a) The primary voltage supplied to the isolating source shall be not less than specified in Section [39](#) for the Input Test. For an isolating source with multiple primary ratings, the highest voltage rating shall be used for this test. Overcurrent protective devices in the branch circuit shall not open as a result of this test;
- b) The maximum open circuit voltage potential available to the secondary circuit under consideration is to be measured directly across the output terminals of the isolating source; and
- c) For an isolating source with multiple secondary circuits, only one secondary circuit is to be tested at a time. All other secondaries not under test are not required to be connected to a load.
- d) The applicable voltage, current and volt-ampere capacity measurements shall be made directly across the secondary output terminals of the isolating source. When a tapped transformer winding is used to supply a full-wave rectifier, the measurements are to be made from either end of the winding to the tap. When the transformer is used as part of a switching-type power supply, the measurements are to be made after the transformer secondary winding rectification means.

53.7.2 Limited energy secondary test

53.7.2.1 With the isolating source connected as in [53.7.1.1](#), the open circuit voltage of the secondary shall not exceed 100 V and the calculated volt-ampere capacity described in [53.7.2.2](#) shall not exceed 200 volt-amperes.

53.7.2.2 The maximum volt-ampere capacity available to the secondary circuit under consideration is to be measured by connecting a variable resistive load across the source of that secondary and then measuring the voltage and current while varying the resistive load from open-circuit to short circuit in 1-1/2 to 2-1/2 minutes. The maximum available volt-ampere capacity is then calculated by multiplying the simultaneously measured values of secondary voltage and secondary current.

53.7.3 Limited voltage secondary test

53.7.3.1 With the isolating source connected as in [53.7.1.1](#), an isolating source that is not provided with secondary overcurrent protection shall be subjected to the test described in [53.7.3.2](#). As a result of the test, there shall be no softening or discoloration of conductor insulation.

53.7.3.2 Each secondary circuit of the isolating source is operated with the secondary short-circuited until ultimate results occur. The opening of an integral protective device or stabilization of temperature is indication of ultimate conditions.

53.7.4 Protective impedance test

53.7.4.1 Protective impedance 15 W

53.7.4.1.1 As specified in [SC1.3.5.1](#), a circuit is able to be evaluated as described in [53.7.4.2.2](#). In addition, the protective impedance shall be subjected to the Protective Impedance Abnormal test in [53.7.2](#).

53.7.4.1.2 Starting at the input to the circuit, the maximum wattage available to the secondary circuit under consideration is to be measured by connecting a variable resistive load between the load side point of each component in line with the source and the supply return. The variable resistance is to be adjusted to a value which maintains a level of 15 watts as measured by a wattmeter. Each component capable of maintaining 15 watts or more for a period of 5 seconds is to be identified as a primary circuit component.

53.7.4.2 Protective impedance abnormal test

53.7.4.2.1 With the isolating source connected as in [53.7.1.1](#), a protective impedance shall not emit molten metal or flames or ignite cotton loosely placed over all openings of ventilated equipment or totally around open type equipment when the components on the load side of the protective impedance are short circuited. Additional trials of this test shall be performed under single component fault conditions of the protective impedance as described in [53.7.4.2.4](#).

53.7.4.2.2 With the isolating source connected as in [53.7.1.1](#), for a circuit supplied by a protective impedance relied upon to reduce the risk of an electric shock shall be determined by measurement as specified in [53.7.4.2.3](#).

53.7.4.2.3 For circuits of [4.22\(e\)](#), voltages and currents are measured between a single accessible part, or any combination of such parts, and either pole of the supply source. The measuring circuit shall have a total impedance of $(1,750 \pm 250)$ W and be shunted by a capacitor such that the time constant of the circuit is (225 ± 15) μ s. Details of a suitable circuit for measuring leakage currents are given in the Leakage Current Test, Section [36](#). The measuring circuit shall have an accuracy of within 5 percent for all frequencies in the range of 20 Hz to 5 kHz. For frequencies above 5 kHz, alternative methods of measurement are required.

53.7.4.2.4 Except as noted in [SC1.3.5.2](#), any circuit component of the protective impedance, such as a resistor, capacitor, or solid-state device shall be subjected to this test while open-circuited or short-circuited, one condition at a time. For a discrete, multiple terminal device, such as a transistor, SCR, triac, or similar device, any combination of terminals taken two at a time shall be open- or short-circuited. For an integrated circuit device, the following combinations of terminals shall be tested:

- a) Each pair of adjacent terminals shorted;
- b) Each input terminal shorted to referenced ground terminal;
- c) Each output terminal shorted to referenced ground terminal;
- d) Each input terminal shorted to each power supply;
- e) Each output terminal shorted to each power supply;
- f) Each terminal open-circuited.

54 Permanence of Markings

54.1 A nameplate on a pump intended for outdoor use shall be of corrosion-resistant material and shall be attached by means not depending upon adhesive unless such means have been investigated and determined to be acceptable for the purpose.

54.2 A required marking is to be molded, die-stamped, paint-stenciled, stamped, or etched on metal, or indelibly stamped on a pressure-sensitive label secured by adhesive that, upon investigation, is found to be acceptable. Ordinary usage, handling, storage, and the like, of the pump shall be considered in determination of the permanence of a marking.

54.3 Unless it has been investigated and found to be acceptable for the application, a pressure-sensitive label or a label secured by cement or adhesive that is required to be permanent shall comply with the requirements in the Standard for Marking and Labeling Systems, UL 969.

54.4 Except as noted in [54.5](#), the required markings of a pump may be provided in the form of a flag-type tag with an adhesive back. The tag is to be wrapped around and adhered to the cord, and the ends of the tag are to adhere to each other and project as a flag. The tag shall be tear-resistant and permanently affixed to the cord set. The leading edge of the tag shall be located within 18 inches (46 cm) of the point where the cord enters the body of the attachment plug. The marking itself shall be indelible.

54.5 The markings of [58.1](#) (a) and (c) shall be on the body of the pump in accordance with [54.1](#) – [54.3](#). They are not prohibited from additionally being on a flag-type tag in accordance with [54.4](#).

54.6 To determine compliance with [54.4](#) flag-type tags with an adhesive back shall comply with the applicable requirements in the Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, for the intended cord surface, specific environmental conditions and limited slippage rating. Alternatively, for flag-type tags used in environmental ambient 40°C (104°F) or lower, the representative tags shall be subjected to the tests described in [54.7](#) – [54.15](#) and meet the following requirements:

- a) The tag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;
- b) The tag shall not separate from the cord set;
- c) The tag shall not slip or move along the length of the cord set more than 1/2 inch (13 mm) and there shall not be any visible damage to the cord;
- d) There shall not be any permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and
- e) Overlamination, if provided, shall remain in place and shall not be torn or otherwise damaged. The printing shall remain legible.

54.7 For [54.8](#), [54.9](#) and [54.10](#), three tags applied to the cord sets in the intended manner are to be used. Exposure conditions and tests are to be conducted no sooner than 24 hours after application of the tag.

54.8 As-Received: After preconditioning, each of three tags is to be tested (in accordance with [54.15](#)) as received.

54.9 Elevated Temperature: Each of three tags is to be tested (in accordance with [54.15](#)) after cooling for 30 minutes at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity, following 240 hours of conditioning in an air-circulating oven at 60 ±1°C (140 ±1.8°F).

54.10 Humidity: Each of three tags is to be tested (in accordance with [54.15](#)) within 1 minute after being exposed for 72 hours to a relative humidity of 85 ± 5 percent at a temperature of $32.0 \pm 2.0^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$).

54.11 If the tag is intended to be applied to outdoor cord (W) it is to be conditioned and tested as follows and in [54.12](#), [54.13](#) and [54.14](#). The requirement in [54.8](#) shall also be applied. Water Immersion: Each of three tags is to be preconditioned for 24 hours at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity, followed by 48 hours of immersion to a depth of not less than 1/8 inch (3.2 mm) in demineralized water at a temperature of $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). After that, each of three tags is to be tested (in accordance with [54.15](#)) within 1 minute following the exposure condition.

54.12 Elevated Temperature: Each of three tags is to be preconditioned for 24 hours at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity, followed by 10 days of exposure in an air-circulating oven at a temperature of 60°C (140°F). After that, each of three tags is to be tested (in accordance with [54.15](#)) after cooling for 30 minutes at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity.

54.13 Low Temperature: Each of three tags is to be preconditioned for 24 hours at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity, followed by 7 hours of exposure in a cold box at a temperature of $-10 \pm 2^{\circ}\text{C}$ ($14.0 \pm 3.6^{\circ}\text{F}$). After that, each of three tags is to be tested (in accordance with [54.15](#)) within 1 minute following the exposure.

54.14 Ultraviolet Light and Water: Each of three tags is to be preconditioned for 24 hours at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity, followed by exposure to ultraviolet light and water spray with ultraviolet light by using either of the following apparatus:

a) A Twin-Enclosed Carbon-Arc Weatherometer, (Type D or DH), as described in the Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G 152 and ASTM G 153. Each of the tags is to be exposed to 720 hours of ultraviolet light and water spray with ultraviolet light. The operating cycle is to be 20 minutes; 17 minutes of ultraviolet light only and 3 minutes of water spray and ultraviolet light, or

b) A Xenon-Arc Weatherometer, (Type B or similar apparatus), as described in the Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, ASTM G 155. Each of the tags is to be exposed to 1000 hours of ultraviolet light and water spray with ultraviolet light. The exposure shall be in accordance with Method A, with continuous exposure to ultraviolet light and intermittent water spray with ultraviolet light, using a programmed cycle of 120 minutes (102 minute ultraviolet light exposures and an 18 minute exposure to water spray with ultraviolet light). The apparatus shall include a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2 at 340 nm and a black-panel temperature of $63.0 \pm 3.0^{\circ}\text{C}$ ($145.0 \pm 5.4^{\circ}\text{F}$).

After that, each of three tags is to be tested (in accordance with [54.15](#)) after 24 hours of conditioning at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity.

54.15 Each test is to be performed on a length of cord set to which the tag has been applied. The cord set, with the attachment plug pointing up, is to be held taught in a vertical plane. A force of 5 pounds (22.2 N), which includes the weight of the clamp, is to be applied for 1 minute to the uppermost corner of the tag farthest from the cord set, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied by affixing a C-clamp with a pad diameter of 3/8 inch (9.5 mm) to the tag and securing the weight to the C-clamp. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. To determine compliance with [54.6\(d\)](#), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with [54.6\(e\)](#), each tag is to be scraped 10 times vertically across printed areas and edges, with a force of approximately 2 pounds (9 N), using the edge of a 5/64 inch (2.0 mm) thick steel blade held at a right angle to the test surface. The edges of the steel blade are to be just rounded so as not to be sharp.

MANUFACTURING AND PRODUCTION-LINE TESTS

55 Dielectric Voltage-Withstand Test

55.1 Each pump shall withstand without electrical breakdown, as a routine production-line test, the application of a DC potential or an AC potential at a frequency within the range of 40 – 70 hertz:

- a) Between the primary wiring, including connected components, and accessible dead-metal parts that are likely to become energized and
- b) Between primary wiring and accessible low-voltage metal parts, including terminals.

55.2 The production-line test shall be in accordance with either Condition A or Condition B of [Table 55.1](#).

Table 55.1
Production-line test conditions

Appliance rating and form	Condition A			Condition B		
	Test potential, V AC	Test potential V DC	Time, seconds	Test potential, V AC	Test potential V DC	Time, seconds
105 – 130 volts, with or without a motor rated 1/2 horsepower (373 W output) or less	1000	1400	60	1200	1700	1
105 – 130 volts with motor rated more than 1/2 horsepower (373 W output)	1000 + 2V ^a	1400 + 2.8V ^a	60	1200 + 2.4V ^a	1700 + 3.4V ^a	1
210 – 600 volts	1000 + 2V ^b	1400 + 2.8V ^b	60	1200 + 2.4V ^b	1700 + 3.4V ^b	1
^a Maximum marked voltage but no less than 120 volts.						
^b Maximum marked voltage but no less than 240 volts.						

55.3 A pump may be in a heated or unheated condition for the test.

55.4 The test shall be conducted when the pump is fully assembled. It is not intended that it be unwired, modified, or disassembled for the test.

Exception No. 1: A part such as a snap cover or a friction-fit knob that interferes with conducting the test is not required to be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed pump.

55.5 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visible indicator of electrical breakdown, and either a manually-reset device to restore the equipment after electrical breakdown or an automatic reject feature activated by an unacceptable unit.

55.6 If the output of the test-equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

55.7 If the output of the test-equipment transformer is 500 volt-amperes or larger, the test potential may be indicated by:

- a) A voltmeter in the primary circuit or in a tertiary-winding circuit,
- b) A selector switch marked to indicate the test potential, or
- c) In the case of equipment having a single test-potential output, a marking in a readily visible location to indicate the test potential.

When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually-reset switch has been reset following a dielectric breakdown.

55.8 Test equipment other than that described in [55.5](#) – [55.7](#) may be used if found acceptable to accomplish the intended factory control.

55.9 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the pump are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

Exception: A pump – resistive, high-impedance winding, and the like – that has circuitry not subject to excessive secondary-voltage buildup in case of electrical breakdown during the test may be tested:

- a) With a single-pole primary switch, if used, in the off position or*
- b) With only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.*

56 Grounding Continuity Test

56.1 Each pump that has a power-supply cord having a grounding conductor shall be tested, as a routine production-line test, to determine that grounding continuity between the grounding blade of the attachment plug and the accessible dead metal parts of the pump that are likely to become energized. Factory-made connections of cords for connection between components shall also be tested.

56.2 Only a single test need be conducted if the accessible metal selected is conductively connected by design to all other accessible metal.

56.3 Any acceptable indicating device, such as an ohmmeter, a battery-and-buzzer combination, or the like, may be used to determine compliance with the grounding-continuity requirement in [56.1](#).

RATINGS

57 Details

57.1 A cord-connected pump shall be rated in amperes, volts, and frequency in one of the following terms: hertz, Hz, cycles per second, cps, cycles/second, c/s, AC-DC, or AC only.

57.2 A permanently-connected pump shall be rated in amperes, volts, and frequency in one of the following terms: hertz, Hz, cycles per second, cps, cycles/second, c/s, AC-DC, or AC only. The number of phases shall also 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 – 660.

Exception: A fountain pump shall not be rated over 300 volts.

57.3 In the case of a pump with a full-load power factor of 80 percent or more, or of a cord-connected unit with a power rating of 50 watts or less, the pump may be rated in watts instead of amperes as required by [57.1](#). All other pumps shall be rated in amperes.

57.4 For a motor-operated pump that is marked with both the motor horsepower and the full-load current, the marked motor full-load current shall be used instead of the horsepower rating to determine the ampacity or rating of the disconnecting means, the branch-circuit conductors, the controller, the overload protection, and the ground-fault protection.

MARKINGS

58 Details

58.1 A pump, or the control or supply box above water in the case of a pump used below water, shall be legibly and permanently marked where readily visible after installation in the case of a permanently-installed pump, with:

- a) The manufacturer's name, trade name, or trademark;
- b) The date or other dating period of manufacturer not exceeding any three consecutive months and not repeating in less than 24 years;
- c) A distinctive catalog number or the equivalent; and
- d) The electrical rating.

Exception No. 1: A submersible pump having no above-ground control shall have the marking on the pump.

Exception No. 2: The manufacturer's identification may be in a traceable code if the pump is identified by the brand or trademark owned by a private labeler.

Exception No. 3: The date of manufacture may be abbreviated or in an established or otherwise acceptable code.

58.2 If a pump uses a single motor as its only electric-energy consuming component, the electrical ratings given on the motor nameplate need not be shown elsewhere on the pump if the motor nameplate is readily visible after installation.

58.3 If a permanently-connected pump uses a dual-voltage motor, and if the motor nameplate is used to give the ratings of the pump as provided in [58.2](#), the pump shall also be marked to indicate the particular voltage for which it has been connected at the factory.

58.4 If a manufacturer produces or assembles pumps at more than one factory, each finished pump shall have a distinctive marking to identify it as the product of a particular factory.

58.5 A pump intended for indoor and outdoor use shall be marked with "Acceptable For Indoor And Outdoor Use" or the equivalent.

58.6 A pump intended for indoor use only shall be permanently marked with "Acceptable For Indoor Use Only" or the equivalent. There shall be no literature, carton markings, or illustrations depicting or implying outdoor use.

58.7 A pump that is intended to circulate heated water shall be permanently marked with the following or equivalent: "For use with maximum ____ °F water." The blank shall be filled with the temperature in degrees Fahrenheit of the water with which the pump has been investigated and determined to be acceptable.

58.8 A submersible pump intended for conduit connection to the electrical supply shall be permanently marked with the following or equivalent statement: "For electrical connection, use rigid metal conduit joined with watertight seal."

58.9 A submersible pump, with or without a water-level actuated switch, that has electrical parts intended to be above water level, shall be marked on its exterior to show the intended level of submersion.

58.10 If a pump will not start and attain normal running speed when connected to a circuit protected by an ordinary (not time-delay) fuse, the pump shall be plainly marked with the following or equivalent statement: "If connected to a circuit protected by a fuse, use a time-delay fuse with this pump."

58.11 A pump not provided with motor protection in accordance with the Exception to [25.2.1](#) 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.

58.12 A pump as mentioned in the Exception to [28.10](#) shall be marked with the following or the equivalent: "An acceptable motor-control switch shall be provided at the time of installation."

58.13 A pump rated for use at more than one voltage or for a range of voltages and containing a tapped transformer or other means of adaption to different supply voltages shall be marked adjacent to the cord or supply compartment to indicate that internal adjustments must be made when the pump is installed or moved.

58.14 A pump as described in [58.13](#) shall be permanently marked with detailed instructions that clearly show the adjustment that must be made for various supply voltages. Such instructions may be on the outside or the inside of the pump where visible at the point where adjustments for supply voltage must be made.

58.15 If any point within a terminal box or wiring compartment of a permanently connected pump in which the power-supply conductors are intended to be connected, including such conductors themselves, reaches a temperature rise of more than 35°C (63°F) during the temperature test, the pump shall be marked with the following or equivalent statement: "For supply connection, use wires acceptable for at least ____°C (____°F)." The temperature value shall be in accordance with [Table 58.1](#). This statement shall be located at or near the point where the supply connections are to be made, and shall be clearly visible both during and after installation of the pump.

Table 58.1
Supply-wire temperature marking

Temperature rise reached during test in terminal box or wiring compartment	Required temperature marking
36 – 50°C (64 – 90°F)	75°C (167°F)
51 – 65°C (91 – 117°F)	90°C (194°F)

58.16 The field-wiring terminals or the area adjacent to the field-wiring terminals shall be marked with the following or equivalent statement, as applicable: "Use copper conductors only," "Use aluminum conductors only," or "For use with aluminum or copper conductors." This marking shall be independent of any marking for terminal connectors and shall be permanent and visible when field-wiring connections are made.

Exception: This marking is not required to be provided for a terminal intended for the connection of a grounding conductor.

58.17 Information regarding the liquids with which a pump has been investigated for use shall be permanently marked on the unit or included in the installation instructions provided with the unit.

Exception: A pump (such as an irrigation pump) that is obviously intended for use with water only need not be marked or provided with additional information in the installation instructions.

58.18 Pumps that are capable of being used with liquids other than water, such as chemical feed pumps, shall be marked in accordance with [58.17](#) or be marked with the word "CAUTION" and the following or the equivalent: "This Pump Has Been Evaluated for Use With Water Only." This information is not prohibited from being included in the installation instructions as specified in [61.8](#).

58.19 With reference to Exception No. 1 to [16.10.2](#), a three-phase, cord-connected submersible pump constructed as described in [16.10.2](#) without provision for supply connection with the cord shall be marked to indicate that one of the methods specified in [16.10.2](#) shall be provided with the cord by the installer for supply connection. The marking shall state that only qualified persons shall conduct service and installation and refer to the installation instructions for further details. It is not prohibited to combine the marking with the marking specified in [58.11](#) or [58.12](#).

58.20 With reference to [16.10.4](#), a three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump shall be marked to indicate that an acceptable motor control shall be provided at the time of installation. The marking shall also specify that service and installation shall be conducted by a qualified person.

58.21 With reference to [16.10.5](#), a three-phase, cord-connected submersible pump shall be marked: "CAUTION" and with the following or equivalent: "Risk of Shock. Do not remove cord and strain relief. Do not connect conduit to pump."

58.22 A submersible pump shall be permanently marked with "Submersible Pump" or the equivalent.

58.23 A nonsubmersible pump shall be permanently marked with "Nonsubmersible Pump" or the equivalent.

58.24 Units intended to meet Exception No. 1 of [16.1.10](#) shall be marked inside the terminal compartment and in the Installation Instructions to indicate they are for use only with flexible wiring systems. The marking shall be visible after installation and shall be not less than 1/16 inch (1.6 mm) high letters.

58.25 Units intended to meet Exception No. 2 of [16.1.10](#) shall be marked inside the terminal compartment and in the Installation Instructions to indicate the supplied hub shall be connected to the conduit before the hub is connected to the enclosure. The marking shall be visible after installation and shall be not less than 1/16 inch (1.6 mm) high letters.

58.26 A pump that complies with the requirements for double insulation as specified in [24.4](#) shall be permanently marked with the words "Double Insulation – When servicing, use only identical replacement parts." The words "Double Insulated" may be used instead of "Double Insulation" in the marking.

58.27 The double-insulation symbol, a square within a square (IEC Publication 417, Symbol 5172), may be used in addition to or in place of the words "Double Insulation." If the symbol is used alone, an explanation of its meaning shall be included in the instruction manual provided with the equipment.

58.28 With reference to Exceptions No. 3 and No. 5(c) to [23.2.1](#) and Exception No. 2 to [23.3.1](#), to avoid segregating or separating Class 2 circuits from non-limited energy power circuits, the following marking or the equivalent shall be provided on the appliance or in the installation instructions: "Wire all Class 2 circuits using Types CL3, CL3R, CL3P, or equivalent conductors."

58.29 With reference to Exception No. 6(c) to [23.2.1](#), to avoid segregating or separating limited energy Class 2 circuits from non-limited energy power circuits, the following marking or the equivalent shall be provided on the appliance or in the installation instructions: "Wire all circuits as Class 1, or Power circuits."

58.30 With reference to [23.5.2](#), when one opening is provided for both non-limited energy and Class 2 limited energy field wired circuits – such as when separate raceways or wiring systems terminate in a tee fitting – the following marking or equivalent shall be provided on the appliance or in the installation instructions: "All Class 2 wiring is to be installed within the flexible tubing provided to maintain separation between circuits."

58.31 With reference to Exception No. 2 to [23.3.1](#), to avoid segregating or separating non-limited energy power field-installed conductors from Class 2 factory-installed conductors, the following marking or the equivalent shall be provided on the appliance or in the installation instructions: "Wire all circuits with insulation rated _____ Vac min." The blank space shall be filled in with the voltage rating of the factory-installed conductors.

59 Cautionary

59.1 A pump having a hidden or unexpected risk of injury to persons shall be marked to inform the user of the risk.

59.2 A cautionary marking shall be permanent and legible and shall be located on a part that cannot be removed without impairing the operation of the pump.

59.3 A cautionary marking intended to warn the operator shall be legible and visible from the position normally assumed by the operator when starting the pump. Other markings (for example, those intended for persons servicing or adjusting the pump) shall be legible and visible to an individual performing such work.

59.4 A marking intended to protect against injury to persons or to warn of specific risk shall be prefixed by the words "CAUTION," "WARNING," or "DANGER" in capital letters not less than 3/32 inch (2.4 mm) high.

59.5 A marking is not required to include a specified signal word – "CAUTION," "WARNING," or "DANGER" – more than once.

59.6 If the construction of a pump contemplates cleaning or servicing, such as the replacement of a pilot lamp or fuse, by the user, and if such cleaning or servicing would involve the exposure of normally enclosed or protected live parts to inadvertent contact, the pump shall be plainly marked to indicate that such servicing or cleaning should be done with the pump disconnected from the supply circuit. The marking shall include the word "CAUTION" and the following or equivalent: "To reduce risk of electric shock, pull plug before servicing this pump."

59.7 A nonsubmersible sump pump shall be plainly marked "CAUTION" and the following or equivalent: "To reduce risk of electric shock, install with motor and all electrical components above the top grade level of the sump. This pump is not submersible."

59.8 A pump shall be permanently marked with the word "WARNING" and the following or equivalent: "Risk Of Electric Shock – This Pump Has Not Been Investigated For Use In Swimming Pool Or Marine Areas." There shall be no literature, carton markings, or illustrations depicting or implying swimming pool or marine use.

59.9 A pump intended for permanent installation shall be marked "WARNING" and the following or equivalent: "To reduce risk of electric shock, see instruction manual for proper installation." This marking shall be visible with the pump in its normal operating position.

59.10 A cord- and plug-connected pump shall be permanently marked "WARNING" and the following or equivalent: "To reduce risk of electric shock, connect only to a properly grounded, grounding-type receptacle." This marking shall be visible with the pump in its normal operating position.

59.11 If, when energized, a pump has a moving part that can cause injury to persons, a switch (other than a momentary contact type) controlling the motor that drives that part shall have a plainly marked off position.

59.12 A pump that is provided with a power supply cord and intended for outdoor use shall be permanently marked with the word "WARNING" and the following or equivalent wording: "To Reduce The Risk Of Electric Shock, Install Only On A Circuit Protected By A Ground-Fault Circuit-Interrupter (GFCI)".

INSTRUCTION MANUAL

60 General

60.1 A pump shall be provided with legible instructions as specified in Installation and Operating Instructions, Section [61](#), and Grounding Instructions, Section [62](#).

60.2 The cautionary prefix "WARNING," required in [62.1](#), shall be in capital letters no less than 3/32 inch (2.4 mm) high.

60.3 The installation, operating, and warning instructions required by Sections [61](#) – [62](#) shall be provided with the product in a printed format (e.g. instruction sheet, manual, booklet or similar printed material).

60.4 All other instructions may be provided in an electronic manual with read only format (e.g. PDF with protection, webpage, file on CD-ROM or DVD). If an electronic manual is offered it shall repeat all instructions required in Sections [61](#) – [62](#).

60.5 If an electronic manual is provided, the printed instruction material required in [60.3](#) shall contain instructions on how to access the electronic manual (e.g. QR Code, website link, CD-ROM, DVD, flash drive) and shall contain detailed instructions on how to obtain a printed copy of the electronic manual.

61 Installation and Operating Instructions

61.1 A permanently installed pump, a submersible contractor pump, and a pump requiring on-site wiring shall be provided with the following:

- a) A wiring diagram that shows intended methods of connection to the supply circuit.

b) For a submersible well pump, instructions for connection of well cable to the motor, and proper support and protection of the cable against damage between the motor and the point of supply connection at ground level.

c) For a pump requiring a minimum rate of flow through or past it, or a certain maximum diameter casing around the pump to permit such flow, information needed to obtain the required flow.

61.2 Instructions shall be provided for the correct installation of a control device needed for proper operation of a pump but not provided with the pump.

61.3 A pump that is intended to pump sewage shall be provided with instructions specifying that the tank is to be vented in accordance with local plumbing codes and shall warn the user that the pump is not to be installed in locations classified as hazardous in accordance with the National Electrical Code, ANSI/NFPA 70.

61.4 The instructions for a fountain pump as specified in [16.11.3](#) shall include the word "WARNING" and the following or equivalent: "To reduce the risk of electric shock, use only on portable self-contained fountains."

61.5 With reference to Exception No. 1 to [16.10.2](#), a three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump constructed in the manner described in [16.10.2](#) without provision for supply connection with the cord shall be provided with instructions for the installation of the devices that are provided in accordance with [58.19](#). These instructions shall specify the location of the devices (such as a box for use inside pump tanks or basin systems), the type of the devices (such as box type, strain relief, water-tight fittings, and similar components) to be used during installation. The installation instructions shall also state that the pump is to be installed in accordance with state and local codes and that only qualified personnel shall service and install the pump.

61.6 With reference to [16.10.4](#), a three-phase cord-connected submersible pump or a single-phase cord-connected sewage, effluent, and grinder pump shall be provided with instructions for the installation of the fixed wire electrical control device. The instructions shall also indicate that an acceptable motor control shall be provided at the time of installation. The instructions shall specify that the pump is to be installed in accordance with state and local codes and that installation and servicing shall be conducted by a qualified person.

61.7 With reference to [16.10.5](#), a three-phase cord-connected submersible pump shall be provided with installation instructions that state: "CAUTION" and the following or equivalent: "Risk of Electric Shock. Do not remove cord and strain relief. Do not connect conduit to pump."

61.8 With reference to [58.18](#), pumps that have not been evaluated for use with liquids other than water shall be provided with instructions including the word "CAUTION" and the following or equivalent: "This Pump Has Been Evaluated for Use With Water Only."

62 Grounding Instructions

62.1 The grounding instructions shall include those Instructions in (a) and (b) applicable to the pump, or the applicable instructions shall be included in the installation and operating instructions. See [60.2](#).

a) For a submersible well pump, the word "WARNING" and the following instructions or the equivalent: "Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding:

- 1) When the means of connection to the supply-connection box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at