UL 763

STANDARD FOR SAFETY

Motor-Operated Commercial Food Preparing Machines

UL Standard for Safety for Motor-Operated Commercial Food Preparing Machines, UL 763

Fifth Edition, Dated February 28, 2018

Summary of Topics

This revision of ANSI/UL 763 dated November 4, 2022 reissues the November 2, 2022 revisions to include the change to B1.3.

The November 2, 2022 revisions included changes in the following requirements which are noted for reference:

– Addition of Standard Operating Controls Options; 6.4.2.1

– Add References to UL 61800-5-1, Standard For Adjustable Speed Electric Power Drive Systems To Replace All References To UL 508C, Standard For Safety For Power Conversion Equipment; 6.11.14, 6.14.2

– Add References to UL 62368-1 As an Option to Evaluate Power Supplies, Secondary Circuits, and of Motor-Operated Commercial Food Preparing Machines; 6.14.2, A2.1, A7.1

– Clarify the Particular Application of the Switch Requirements and Updating the Requirements to Align with the Latest Edition of UL 61058 Series; 6.19.1.2 – 6.19.1.4, 6.19.1.6, 6.19.1.8,

– Clarify The Application Of Test Requirements To Rechargeable Battery-Powered Food-Preparing Machines With Respect To Accessible Parts; B1.3

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated October 8, 2021, December 17, 2021, and September 16, 2022.

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FEBRUARY 28, 2018
(Title Page Reprinted: November 4, 2022)

ANSI/UL 763-2022

UL 763

Standard for Motor-Operated Commercial Food Preparing Machines

First Edition – January, 1985
Second Edition – October, 1993
Third Edition – November, 2000
Fourth Edition – January, 2012

Fifth Edition

February 28, 2018

This ANSI/UL Standard for Safety consists of the Fifth edition including revisions through November 4, 2022.

The most recent designation of ANSI/UL 763 as an American National Standard (ANSI) occurred on November 2, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 763 on October 3, 1994. 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.

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INTRODUCTION

1 Scope

1.1 These requirements cover commercial motor-operated food-preparing machines intended for use in accordance with the National Electrical Code.

1.2 These requirements do not cover machines rated more than 600 V; nor do they cover machines involving universal motors rated more than 250 V.

1.3 These requirements cover coffee grinders, vegetable cutters, food mixers, nonrefrigerated ice cube dispensers, and other motor-operated machines usually found in commercial kitchens, restaurants, food processing establishments, bakeries, or other business establishments where food is prepared or processed.

1.4 A machine that utilizes some other source of energy, such as gas or steam, in addition to electric energy will be investigated under these requirements and under such additional requirements as are applicable to the machine under consideration.

1.5 These requirements also cover portable rechargeable battery-powered appliances for indoor or outdoor use with rechargeable non-user and user-replaceable batteries; see Appendix B.

2 Terminology

2.1 In the following text, a requirement that applies only to a specific type or types of commercial food-preparing machine is identified by a specific reference in the requirement to the type or types of machine involved. Absence of such a specific reference or use of the term machine indicates that the requirement applies to all of the types of equipment covered by this standard.

3 Glossary

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

3.2 APPLIANCE COUPLER – A single-outlet, female contact device for attachment to a flexible cord as part of a detachable power-supply cord to be connected to an appliance inlet (motor attachment plug).

3.3 APPLIANCE INLET (Motor Attachment Plug) – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

3.4 APPLIANCE (FLATIRON) PLUG – An appliance coupler type of device having a cord guard and a slot configuration specified for use with heating or cooking appliances.

3.5 ATTENDED EQUIPMENT – Equipment intended for use where operator presence is required for the equipment to function but is not necessarily required for the equipment to operate. Operator absence is effectively limited to short durations due to one or more characteristics of the equipment such as production of excessive noise or vibration. Examples may include hand-held mixers, meat saws, meat slicers, food processors, and blenders.

3.6 AUTOMATICALLY CONTROLLED MACHINE – A machine is considered to be automatically controlled under any one or more of the following conditions if:

a) The repeated starting of the machine, beyond one complete predetermined cycle of operation to the point where some form of limit switch opens the circuit, is independent of any manual control.

b) During any single predetermined cycle of operation, the motor is caused to stop and restart one or more times.

c) Upon energizing the machine, the initial starting of the motor may be intentionally delayed beyond normal, conventional starting.

d) During any single predetermined cycle of operation, automatic changing of the mechanical load may reduce the motor speed sufficiently to reestablish starting-winding connections to the supply circuit.

3.7 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to the purpose. When incorporated in an appliance, equipment otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

3.8 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. Operating controls are also referred to as "regulating controls".

3.9 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. Protective controls are also referred to as "limiting controls" and "safety controls".

3.10 ELECTRONIC DISCONNECTION – non-cycling interruption by an electronic device (a device which produces a dynamic imbalance of electrons) of a circuit for functional disconnection and which provides a disconnection other than by means of an air gap by satisfying certain electrical requirements in at least one pole.

3.11 ENCLOSURE – That part of the machine that:

a) Renders inaccessible all or any parts of the equipment that involve a risk of electric shock or injury to persons, or

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

3.12 INDOOR LOCATION – Inside a building where not normally subjected to the effects of weathering.

3.13 INTERLOCK – A device or arrangement by means of which the functioning of one part is controlled by the functioning of another, for safety purposes.

3.14 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 V and having circuit characteristics in excess of those of a low-voltage circuit.

3.15 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of not more than 42.4 V supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

3.16 OUTDOOR LOCATION – In the open and subjected to the full effects of weathering.

3.17 PROTECTED LOCATION – In an area that is partially protected from the effects of weathering through the use of a roof, canopy, marquee, or similar structure.

3.18 REMOTELY CONTROLLED MACHINE – A machine that is out of sight of the operator who is at the starting device.

3.19 STAND-BY CIRCUIT – A circuit that energizes the appliance control though the movable parts of the appliance are not in motion. The appliance is not yet operational until the user presses the START or ON switch (e.g. an appliance that is in stand-by mode is ready-to-operate).

3.20 MOMENTARY CONTACT ON/OFF SWITCH – A switch intended to energize an appliance when pressed. Constant pressure is required to keep the unit energized.

3.21 WAND-TYPE MIXER (may also be known as an immersion blender) – Is a hand-held, portable appliance that is intended to process foods in a container. It is equipped with a rotating shaft (wand) with a mixing/blending head which is immersed into the food to crush, mix, mash, emulsify, etc. into soups, mashes, purees, sauces, mayonnaise, cream, dairy products and more generally to process all solid, liquid, pasty or powdery foods to obtain a homogeneous fluid. The mixing/blending head is a cutting tool composed of high-speed rotating blades located at the end of the shaft. These appliances may be provided with a whipping or beater whisk attachment. A whipping whisk is comprised of flexible and long wires gathered together around one or several rotating shaft(s) and a beater whisk is identical except comprised of metal strips (bands).

4 Units of Measurement

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

5 References

5.1 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.

CONSTRUCTION

6 Components

6.1 General

6.1.1 Except as indicated in 6.1.2, a component of a product covered by this standard shall comply with the requirements for that component, as indicated in 6.2 through 6.19 and the additional component requirements of this standard.

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

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

b) Is superseded by a requirement in this standard, or

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

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

6.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

6.1.5 A component not anticipated by the requirements of this standard, not specifically covered by the component standards specified in this standard and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated.

6.1.6 With respect to 6.1.5, reference to construction and performance requirements in another UL end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of UL 763.

6.1.7 Unless otherwise specified, components that do not present a risk of electric shock, fire of injury to persons, such as connectors in a low voltage circuit where the power available is limited to 15 W, are not required to meet the specified component standards.

6.2 Attachment plugs, receptacles, connectors, and terminals

6.2.1 Attachment plugs, appliance couplers, receptacles and appliance inlets (motor attachment plugs) shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

Exception: Attachment plugs and appliance couplers integral to power supply cords are covered under the requirements of the Standard for Cord Sets and Power-Supply Cords, UL 817 and need not comply with UL 498.

6.2.2 Female devices (such as appliance couplers and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

6.2.3 Quick-connect terminals, both connectors and tabs, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310, and shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated, the rated voltage and temperature shall be suitable for the intended use. Quick-connect terminals shall be applied per the installation instructions of the quick-connect terminal manufacturer.

6.2.4 Single and multipole connectors for use in data, signal, control and power applications within the appliance intended for factory assembly to copper or copper alloy conductors or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977.

6.2.5 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B, the Standard for Splicing Wire Connectors, UL 486C, or the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, and shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated, the rated voltage and temperature shall be suitable for the intended use. Wire connectors shall be applied per the installation instructions of the wire connector manufacturer.

6.2.6 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring. A terminal block shall be suitable for the number of conductors per

termination, wire size, type (solid or stranded), conductor material (copper or aluminum), voltage and current of the intended use.

6.2.7 A 15- or 20-A general-use receptacle in a machine provided with a means for grounding shall be of the grounding type. The grounding contact of the receptacle shall be electrically connected to dead metal that will be grounded when the machine is in use.

6.2.8 Each circuit having a receptacle intended for general use, shall have overcurrent protection of not more than 20 A provided as a part of the machine if the overcurrent protection of the branch circuit to which the machine will properly be connected exceeds that acceptable for the receptacles. The overcurrent protection provided shall be of the time-delay type.

6.2.9 A fuseholder provided in accordance with 6.2.8 shall be of Type S construction or shall be of the Edison-base type with a factory-installed nonremovable adapter of Type S construction.

6.2.10 The face of a receptacle shall:

a) Be flush with or project beyond a nonconductive surrounding surface, or

b) Project at least 0.015 inch (0.38 mm) beyond a conductive surrounding surface.

6.2.11 The terminal or lead of a receptacle intended to be grounded shall be connected to the conductor of the power-supply cord that is intended to be grounded. Table 12.1 identifies the supply cord conductor intended to be grounded.

6.2.12 Receptacles mounted to and supported by a cover shall be secured by more than one screw or shall be a device assembly or box cover intended for securing by a single screw.

6.3 Capacitors and filters

6.3.1 Capacitors that are connected between the ungrounded and grounded conductors (across the line) or from one of these conductors to exposed dead metal of the appliance shall comply with the:

a) Standard for Electromagnetic Interference Filters, UL 1283;

b) 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.

6.3.2 A capacitor provided as a part of a motor and a capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that protects the plates against mechanical damage and prevents the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall be of metal provided strength and protection not less than 0.020 inch (0.51 mm) thick uncoated steel.

Exception No. 1: The individual container of a capacitor may be of sheet metal less than 0.020 inch (0.51 mm) thick or may be of material other than metal if the capacitor is mounted in an enclosure that houses other parts of the machine and provided that such housing is acceptable for the enclosure of live parts.

Exception No. 2: A capacitor complying with the Standard for Capacitors, UL 810 or an electromagnetic interference filter with an integral enclosure complying with the Standard for Electromagnetic Interference Filters, UL 1283, is considered to be adequately protected.

6.3.3 If a capacitor that is not part of a motor is connected in a machine that is intended to be automatically or remotely controlled so that malfunction or breakdown of the capacitor would result in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the machine to preclude such a condition.

6.3.4 A capacitor connected from one side of the line to the frame or enclosure of a machine shall have a capacitance rating of not more than 0.10 microfarad.

6.3.5 A machine that is intended to be controlled by or operated in conjunction with a capacitor or a capacitor/transformer unit shall be supplied with such capacitor or unit.

6.3.6 Under both normal and abnormal conditions of use, a capacitor employing a dielectric medium more combustible than askarel shall not cause a risk of electric shock or fire, as determined by compliance with the applicable tests in this standard intended to stimulate normal use and any forseeable abnormal uses of the machine, and shall be protected against expulsion of the dielectric medium.

Exception: A protected capacitor complying with the Standard for Capacitors, UL 810, or an electromagnetic interference filter complying with the Standard for Electromagnetic Interference Filters, UL 1283, is considered to have adequate protection against expulsion of the dielectric medium.

6.4 Controls

6.4.1 General

6.4.1.1 Components, wiring, printed wiring assemblies, insulation materials, and the like, and associated circuitry employed in controls shall be investigated and found acceptable for the application in accordance with the specific control standards with respect to the risk of electric shock, fire and injury to persons.

6.4.1.2 Where reference is made to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, this shall include both the Part 1: General Requirements and, where applicable, the relevant Part 2 Particular Requirements.

6.4.2 Operating controls

6.4.2.1 Operating controls shall comply with one of the following:

a) The Evaluation of Electronic Circuits, Supplement SA; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the applicable Part 2; or

c) The Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, with the Standard for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1 or Low-Voltage Switchgear and Controlgear – Part 5-1: Control Circuit Devices and Switching Elements – Electromechanical Control Circuit Devices, UL 60947-5-1; or

e) The Standard for Programmable Controllers – Part 2: Equipment Requirements and Tests, UL 61131-2; or

f) The Standard for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements, UL 61010-1 with the Standard for Safety Requirements for Electrical

Equipment for Measurement, Control, and Laboratory Use – Part 2-201: Particular Requirements for Control Equipment, UL 61010-2-201.

6.4.2.2 A control regulating the motor speed, limiting the operating time during normal operation, or starting or stopping the motor, and any other control not relied upon for compliance with this standard shall be evaluated as an operating control.

Exception: An electronic control serving as the motor control switch in accordance with 28.3 or acting as an interlock required for compliance with this standard, shall be evaluated as a protective control.

6.4.2.3 When evaluating an operating control to UL 60730-1, the minimum test parameters specified in Table 6.1 shall be applied.

Table 6.1
Operating control parameters

Operating control parameter	Minimum specification
FMEA	Conduct a failure-mode and effect analysis (FMEA) to identify component failures which may result in a risk of electric shock or fire.
Operating Ambient	Determined via the Normal Temperature Test on the appliance (Section 36)
Endurance Testing	6000 cycles of operation required for controls starting or stopping the motor
Overvoltage Category	As specified in Table 18.2
Pollution Degree	As specified in Table 18.1
Enclosure Flammability	V-2 for portable appliances or 5VB for other appliances

6.4.3 Protective controls

6.4.3.1 Protective controls shall comply with:

a) The Evaluation of Electronic Circuits, Supplement SA; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the applicable Part 2.

6.4.3.2 In addition to the standards referenced in 6.4.3.1, electronic protective controls shall also be evaluated for reliability in accordance with:

a) The Evaluation of Electronic Circuits, Supplement SA of this Standard; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the applicable Part 2, except Clause H 11.12 (Controls using software).

6.4.3.3 In addition to the standards referenced in 6.4.3.1, electronic protective controls relying upon software as a protective component shall also comply with:

a) The Evaluation of Electronic Circuits, Supplement SA of this Standard; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the applicable Part 2.

6.4.3.4 A control serving as motor overload protection required in accordance with 6.11, serving as the motor control switch in accordance with 28.3, limiting the operating time under abnormal operating conditions or acting as an interlock required for compliance with this standard, and any other control relied upon for compliance with this standard shall be evaluated as a protective control.

Exception: If the appliance complies with this standard with the control defeated, the control shall be evaluated as an operating control.

6.4.3.5 When evaluating a protective control to UL 60730-1, the minimum test parameters specified in Table 6.2 shall be applied.

Table 6.2
Protective control parameters

Protective control parameter	Minimum specification
FMEA	Conduct a failure-mode and effect analysis (FMEA) to identify component failures which may result in a risk of electric shock, fire or injury and confirming protective function continues to operate as intended.
Operating Ambient	Determined via the Normal Temperature Test on the appliance (Section 36)
Endurance Testing	• 100,000 cycles of operation for interlocks, • 50 cycles for manual reset motor overload protection, • 15 days for automatic reset motor overload protection • 6000 cycles of operation required for controls starting or stopping the motor
Overvoltage Category	As specified in Table 18.2
Pollution Degree	As specified in Table 18.1
Enclosure Flammability	V-2 for portable appliances or 5VB for other appliances
Conducted Disturbances	Test Level 3
Radiated Electromagnetic Fields	Test Level 3
Fast Transient Bursts	Test Level 3 applied for 2 minutes in each polarity
Surge Immunity	Installation Class 2
Electrostatic Discharge	Test Level 3
Thermal Cycling	Temperature range: 10.0 ± 2 °C to the Operating Ambient
Software Class	Software Class B (See 6.4.3.3)

6.5 Cords, cables, and internal wiring

6.5.1 A power supply cord shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817.

6.5.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a power supply cord complying with the Standard for Cord Sets and Power Supply Cords, UL 817.

6.5.3 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

Exception No. 1: Insulated conductors need not comply with UL 758 if they comply with:

a) The Standard for Thermoset-Insulated Wires and Cables, UL 44;

b) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83; or

c) The Standard for Fixture Wire, UL 66.

Exception No. 2: Insulated conductors located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with UL 758.

6.6 Cord reels

6.6.1 A cord reel shall comply with the special-use cord reel requirements of the Standard for Cord Reels, UL 355.

6.7 Field wiring boxes and raceways

6.7.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3, Wiring Methods and Materials, of the National Electrical Code, ANSI/NFPA 70 and that comply with the relevant UL standard (such as the Standard for Metallic Outlet Boxes, UL 514A, the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, or the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D) and the requirements in General, Section 6.1 are considered to comply with the requirements in this end product standard.

6.8 Heating elements

6.8.1 Heating elements shall comply with the following standards, as applicable:

a) Standard for Sheathed Heating Elements, UL 1030, for sheath-type heating elements;

b) Standard for Appliance Wiring Material, UL 758, for heating wire (rope heaters); or

c) Standard for Electric Heating Appliances, UL 499, for other heating elements.

6.8.2 The voltage rating of a heating element employed in a machine shall not be less than that specified in Table 6.3.

Table 6.3
Rating of heating element

Nominal voltage of circuit	Minimum rating of heating element, volts
120	110
208	208
240	220
277	277
480	430
More than 480	Rating of circuit

6.9 Lampholders, indicating lamps and lighting ballasts

6.9.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

6.9.2 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use In Lighting Products, UL 8750, unless the LED light source forms a part of a

luminaire complying with the appropriate UL Standards. Individual light emitting diodes mounted on the printed wiring board of a control and intended for indicating purposes shall be evaluated with the control.

6.9.3 Lighting ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, UL 935, or the Standard for High-Intensity-Discharge Lamp Ballasts, UL 1029, unless the ballast forms a part of a luminaire complying with the appropriate UL Standard.

6.9.4 The screw shell of an Edison-base lampholder shall be connected to the terminal or lead that is intended to be connected to the grounded conductor of the power-supply circuit. Table 12.1 identifies the supply cord conductor intended to be grounded.

6.10 Motors

6.10.1 A motor shall be acceptable for the application, and shall be capable of handling the maximum normal load of the machine as described in 33.2 and 36.2.1 – 36.20.5 without introducing a risk of fire, electric shock, or injury to persons.

6.10.2 A motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

Exception: A motor located in a Low Voltage Circuit may be evaluated only for the Risk of Fire and Personal Injury in accordance with the applicable requirements of this standard.

6.10.3 With respect to evaluation of a motor to the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, the following exceptions shall be applied:

a) Motor controls shall be evaluated in accordance with 6.4.

b) Parts of phenolic material in contact with live parts, other than magnet wire, such as brush holders or commutator insulation, shall be considered suitable without further evaluation of the material's electrical insulating properties if the material has:

1) A flammability rating of at least HB, and

2) A suitable relative thermal index (RTI) for the temperatures obtained during the Normal Temperature Test.

c) Parts of other materials in contact with live parts, other than magnet wire, shall be evaluated in accordance with 14.2.

d) For motors utilizing alternative spacings specified in the Standard for Insulation Coordination including Clearances and Creepage Distances for Electrical Equipment, UL 840, conditions and requirements as specified in Section 18, Alternate Spacings – Clearances and Creepage Distances shall be applied.

6.11 Motor overload protection

6.11.1 An machine shall incorporate thermal or overload protection in accordance with 6.11.4 if it is:

a) Permanently connected, continuous duty, and manually started, employing a motor rated at 1 hp (746 W output) or less,

b) A machine with load characteristics likely to result in an overload or stalled condition that will not be evident to the user, or

c) Remotely or automatically controlled.

6.11.2 A motor intended to move air only by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running-overload protection.

6.11.3 A shaded-pole motor with a 2:1 or smaller ratio between locked-rotor and no-load currents and a 1 A or smaller difference between no-load and locked-rotor currents is considered to have acceptable overload protection if it is protected against locked-rotor conditions only.

6.11.4 Motor-overload protection required for an appliance shall consist of one of the following:

a) Thermal motor protection complying with 6.11.6.

b) Impedance motor protection complying with 6.11.7, when the motor is tested as used in the appliance under locked-rotor conditions.

c) Electronic motor protection complying with 6.11.8.

d) Other protection that is shown by test to be equivalent to the protection as specified in (a).

6.11.5 With respect to 6.11.4, for an appliance that includes a control that positively and reliably limits the length of the time the appliance can operate under normal operation, the duration of the temperature test and the endurance test, both under locked-rotor conditions, may be less than that specified but shall not be less than the time the appliance can operate. If an electronic control operates only under abnormal conditions to end the test or limit the motor temperatures, the control shall be evaluated as electronic motor protection per 6.11.4(c) or the test shall be repeated with the electronic control defeated.

6.11.6 Thermal motor protection shall comply with the:

a) Standard for Thermally Protected Motors, UL 1004-3; or

b) Standard for Thermal Links – Requirements and Application Guide, UL 60691.

6.11.7 Impedance motor protection shall comply with the Standard for Impedance Protected Motors, UL 1004-2.

6.11.8 Electronic motor protection shall comply with the Standard for Electronically Protected Motors, UL 1004-7.

6.11.9 With respect to the evaluation of electronic motor protection in accordance with 6.11.8, the control shall be evaluated in accordance with 6.4 as a protective control.

6.11.10 The functioning of a motor-protective device provided as part of an appliance (whether such device is required or not) shall not result in a risk of fire, electric shock, or injury to persons.

6.11.11 Fuses employed for motor-running overcurrent protections shall be located in each ungrounded conductor; and for a 3-wire, 3-phase, alternating-current motor, in each of the three phases.

6.11.12 Overload devices employed for motor-running overcurrent protection, other than those that are inherent in a motor, shall be located in at least one ungrounded conductor of a single-phase supply system and in each ungrounded conductor of a 3-phase supply system.

6.11.13 With reference to 6.11.4(d), an overcurrent-protective device conforming with the National Electrical Code, is considered to be an overcurrent device that is responsive to motor current and is rated or set as indicated in Column A of Table 6.4. If the rating of the motor-running overcurrent protection determined in accordance with the foregoing does not correspond to a standard size or rating of fuses, nonadjustable circuit breakers, thermal cutouts, thermal relays, or heating elements of thermal-trip motor

switches, the next higher size, rating, or setting may be used, but not more than that specified in Column B of Table 6.4. For a multispeed motor, each winding connection is to be considered separately.

Table 6.4
Maximum rating of setting of overcurrent-protective device

Type of motor	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	125	140
Motor with marked temperature rise of 40°C (72°F) or less	125	140
Any other motor	115	130

6.11.14 With reference to 6.11.4(d), power conversion equipment is considered equivalent to thermal or impedance protection if it has been evaluated to the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1, incorporates motor overload protection, and is suitably rated for use with the motor employed.

6.11.15 Fuses shall not be used as motor-overload protective devices unless the motor is protected by a time-delay fuse of the highest ampere rating that can be inserted in the fuseholder.

6.11.16 Motor-overload protection in which contacts control a relay coil in a motor starter shall comply with the requirements in 6.11.4.

6.11.17 For a multispeed motor of any of the types mentioned in 6.11.1 that employs a separate overload protective device to provide running overload protection, the requirement in that paragraph applies at all speeds at which the motor is intended to operate.

6.12 Overcurrent protection

6.12.1 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable Part of the UL 248 Series for the specific fuse type.

6.12.2 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part of the UL 4248 Series for the specific fuseholder type.

6.12.3 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

6.12.4 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

6.12.5 Contactors and overload relays shall comply with the Standard for Industrial Control Equipment, UL 508, or the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1, with the Standard for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1.

6.12.6 A protective device shall be wholly inaccessible from outside the appliance except that the operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts may project outside the appliance enclosure.

6.12.7 If an appliance is provided with a single-pole overcurrent protective device and is required to employ a polarized plug, the overcurrent protective device shall be connected to the ungrounded conductor of the power-supply cord of an appliance. Table 12.1 specifies the polarity identification of the power-supply cord conductors.

Exception: For portable, non-automatically starting appliances employing a motor rated 1-hp or less intended to be operated on a nominal 120 volts branch circuit and employing a plug rated at 15-amperes, an overcurrent protective device within the appliance is not prohibited from being located in either conductor of the power-supply cord, when the overcurrent protective device acts only as a supplementary overcurrent protector.

6.12.8 If the current rating of a machine is more than 40 A, and there are subdivided circuits within the machine feeding two or more power-consuming components – motors, motor-control circuits, electric heating elements – connected in parallel with each other across any pair of main-supply terminals or leads, overcurrent protection shall be provided as a part of the machine for the conductors of each terminal circuit.

Exception: Additional overcurrent protection is not required as a part of the machine for the conductors of the subdivided circuits described below:

a) For each separate motor or heating-element circuit supplied by insulated conductors having an ampacity at least one-third that of the protective device in the branch circuit to which the machine will properly be connected.

b) For each separate motor-control circuit supplied by insulated conductors having an ampacity at least one-fifth that of the protective device in the branch circuit to which the machine will properly be connected.

6.13 Polymeric materials and enclosures

6.13.1 Polymeric materials shall have:

a) A suitable flammability rating in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C;

b) A suitable Functional-Use Temperature Index, Generic Thermal Index, or Relative Thermal Index (RTI) in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C; and

c) Comply with the performance requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

See also Section 14, Insulating Material, for polymeric insulating materials and Section 8, Frame and Enclosure, for polymeric enclosures.

Exception: If the deterioration of a part formed of polymeric material does not result in noncompliance with this standard, the thermal index need not be determined.

6.13.2 Metallized polymeric parts or enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. This requirement is not applicable to metallized coating applied only to the exterior surfaces of the appliance such that flaking of the coating is not likely to enter the electrical enclosure of the appliance.

6.14 Power supplies

6.14.1 A Class 2 power supply shall comply with the Standard for Class 2 Power Units, UL 1310.

6.14.2 A non-Class 2 power supply shall comply with one of the following:

a) Standard for Power Units Other Than Class 2, UL 1012; or

b) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1; or

c) Standard for Industrial Control Equipment, UL 508; or

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

e) Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

6.15 Printed wiring boards

6.15.1 Printed wiring boards, including coatings, shall comply with the Standard for Printed Wiring Boards, UL 796.

6.15.2 Printed wiring boards shall have a flammability class of at least HB.

6.15.3 Printed wiring boards containing line voltage circuits shall be rated for direct support.

6.16 Semiconductors, relays and small electrical and electronic components

6.16.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Section 40 of this end product standard.

6.16.2 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 comply with the Standard for Optical Isolators, UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Section 34 of this end product standard.

6.16.3 Except as otherwise specified in this standard, component requirements are not specified for small electrical parts on printed wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

6.16.4 Relays shall comply with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, or the Standard for Industrial Control Equipment, UL 508.

6.17 Solenoids and electrically operated valves

6.17.1 Solenoids shall comply with the Outline of Investigation for Solenoids, UL 906.

6.17.2 Electrically operated valves shall comply with:

a) The Standard for Electrically Operated Valves, UL 429; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

6.18 Supplemental insulation, insulating bushings and assembly aids

6.18.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required for compliance with this standard. In such cases:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510 or UL 510A;

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441;

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

Note: UL 510 covers tape rated up to 80 °C, and UL 510A covers tape rated greater than 80 °C.

6.18.2 Wire positioning devices required for compliance with this standard shall comply with the Standard for Positioning Devices, UL 1565.

6.18.3 Insulating bushings required for compliance with this standard shall comply the Standard for Insulating Bushings, UL 635. Tests specified in this Standard (e.g. Strain Relief Test) may still need to be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

6.19 Switches, timers and interlocks

6.19.1 Switches

6.19.1.1 Switches shall comply with:

a) The Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1; or

b) The Standard for General-Use Snap Switches, UL 20.

6.19.1.2 A switch shall be appropriate for the particular application, and shall have a current and voltage rating not less than that of the maximum load it controls in the appliance, as specified in 6.19.1.3 – 6.19.1.6 or 6.19.1.7 – 6.19.1.8.

6.19.1.3 In the application of 6.19.1.2, switches that comply with the UL 61058-1 shall be rated as specified in 6.19.1.4 – 6.19.1.6.

6.19.1.4 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 shall be rated for resistance and motor load in accordance with 7.2.2 of UL 61058-1; or

2) Switches may be rated for a declared specific load (e.g., rated for motor load) in accordance with 7.2.5 of UL 61058-1, 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.

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

6.19.1.6 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) *Deleted*

2) Switches with a rating of 20 mA or less classified in 7.2.6 of UL 61058-1.

6.19.1.7 In applying the requirement in 6.19.1.2 to a switch controlling a motor, the switch shall have a horsepower rating not less than that of the controlled motor.

Exception: A switch with suitable general purpose voltage and current ratings, but without a suitable horsepower rating, may be used if it complies with the Switch Overload Test of 48 or if:

a) The power factor in the locked rotor condition is at least 80 percent; and

b) The locked rotor current is not more than 150 percent of the switch rating, for switches rated 10 A or less; or

c) The locked rotor current is not more than 125 percent of the switch rating, for switches rated greater than 10 A.

6.19.1.8 In applying the requirement in 6.19.1.2, the resistive current rating of a switch that controls an inductive load other than a motor, such as a transformer, electric-discharge-lamp ballast or relay, shall not be less than twice the rated full-load current of the inductive load, unless the switch has been investigated and found acceptable for the application.

6.19.1.9 In a permanently connected machine nominally rated 120 or 120/240 V (3-wire), no switch or overcurrent-protective device of the single-pole type, other than an automatic control without a marked off position, shall be electrically connected to a terminal or lead intended for connection to the grounded conductor of the supply circuit.

6.19.1.10 A manually operated motor-control switch shall be provided in a cord-connected machine that employs a motor rated more than 1/3 horsepower (250 W output).

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

6.19.1.12 A manually operated, line-connected, single-pole switch, or other control device, intended for on-off operation of the machine shall be connected to the ungrounded conductor of the power-supply cord. Table 12.1 specifies the polarity identification of the power-supply cord conductors.

6.19.1.13 Snap switches mounted in boxes shall have faceplates installed so as to completely cover the opening and seat against the finished surface.

6.19.1.14 Snap switches shall be effectively grounded and a means shall be provided to ground metal faceplates, whether or not a metal faceplate is installed. Snap switches shall be considered effectively grounded when either of the following conditions are met:

a) The switch is mounted with metal screws to a metal box or to a nonmetal box with integral means for grounding devices.

b) An equipment-grounding conductor or equipment bonding jumper is connected to an equipment-grounding termination of the snap switch.

Exception: Double-insulated snap switches are not required to be effectively grounded.

6.19.2 Timing switches and controls

6.19.2.1 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent electro-mechanical arrangements shall comply with:

a) The Standard for Clock-Operated Switches, UL 917; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

6.19.2.2 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, shall be evaluated in accordance with 6.4.

6.19.3 Interlock systems

6.19.3.1 Operation of an interlock in intended use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

6.19.3.2 An interlock shall not be capable of being defeated by food that could accumulate in intended use.

6.19.3.3 An interlock shall be such that it cannot be defeated readily:

a) Without damaging the machine,

b) Without making wiring connections or alterations, or

c) By the probe as shown in Figure 11.1.

6.19.3.4 If an interlock is actuated by movement of a guard, the arrangement shall be such that the guard is in place when the interlock is in the position that permits operation of the parts being guarded. With the guard removed, the interlock shall comply with the requirements in 28.4.

6.19.3.5 An interlock system shall have an endurance rating of 100,000 cycles of operation at not less than the rating of the load it controls. If the interlock system has not been shown to have been investigated for the purpose, it shall be subjected to the Interlock System Endurance Test, Section 49.

6.20 Transformers

6.20.1 General-purpose transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

6.20.2 Class 2 and Class 3 transformers shall comply with the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception: Transformers located in a low voltage circuit, not involving a risk of fire or personal injury, need not comply with this requirement.

7 Field Attached Accessories

7.1 A machine having provisions for the use of electrical accessories to be attached in the field shall be constructed so that the use of these accessories will not introduce a risk of fire, electric shock, or injury to persons.

7.2 The machine shall comply with all requirements of this standard with or without the accessory installed.

7.3 Installation of accessories by the user shall be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors.

7.4 Installation of accessories by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

7.5 With reference to 7.4, an installation shall not require the cutting of wiring or the soldering of connections by the installer. Installations shall not require cutting, drilling, or welding in electrical enclosures and in other areas where such operations may damage electrical components and wiring within the enclosure.

7.6 Strain-relief means shall be provided for the wiring in the accessory when there is a possibility of transmitting stress to the terminal connections during installation unless the wiring is located in a low-voltage circuit the functioning of which is not relied upon for compliance with this standard. See Strain Relief Test, Section 51.

7.7 Each terminal and wiring intended to be field connected shall be identified on the:

a) Accessory,

b) Commercial food preparing machine when connections are to be made between the accessory and the machine, and

c) Wiring diagram(s).

7.8 The mounting location of the accessory shall be indicated on the machine.

Exception: When the mounting location is fixed due to the function of the accessory and arrangement of the machine, and instructions are provided specifying the installation and location for the accessory, the mounting location of the accessory need not be indicated on the machine.

7.9 The intended installation of the accessory shall be indicated in the installation instructions included on or with the accessory. See 64.1.

7.10 An electrical accessory intended for field installation shall be marked in accordance with 63.5.3.

7.11 As part of the investigation, accessories are to be tested as described in the Accessory Installation Test, Section 59, in case of doubt, to determine that:

a) Their installation is feasible,

b) The instructions are detailed and correct, and

c) The use of the accessories does not introduce a risk of fire, electric shock, and injury to persons.

8 Frame and Enclosure

8.1 A machine shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses that it is likely to be subjected to, without increasing the likelihood 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.

8.2 Cast- and sheet-metal portions of the enclosure shall not be thinner than indicated in Table 8.1 unless the enclosure is found to be acceptable when investigated under considerations such as are mentioned in 8.3 and 8.4.

Table 8.1
Minimum acceptable thickness of enclosure metal

Metal	At small flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, and the like (or are otherwise of a shape and/or size) to provide physical strength		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	inches	(mm)	inches	(mm)	inches	(mm)
Die-cast	3/64	(1.2)	–	–	5/64	(2.0)
Cast malleable iron	1/16	(1.6)	–	–	3/32	(2.4)
Other cast metal	3/32	(2.4)	–	–	1/8	(3.2)
Uncoated sheet steel	0.026[a]	(0.66)[a]	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029[a]	(0.74)[a]	0.034	(0.86)	0.029	(0.74)
Nonferrous sheet metal	0.036[a]	(0.91)[a]	0.045	(1.14)	0.036	(0.91)

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is investigated under considerations such as those mentioned in 8.4.

8.3 In addition to being considered with reference to the factors mentioned in 8.4, an enclosure of sheet metal is to be investigated with respect to its size and shape, the thickness of metal and its acceptability for the particular application, considering the intended use of the machine.

8.4 Among the factors that are to be taken into consideration when determining the acceptability of an enclosure are:

a) The mechanical strength,

b) Resistance to impact,

c) Moisture-absorptive properties,

d) Combustibility, and

e) Resistance to distortion at temperatures to which the material may be subjected under conditions of normal or abnormal usage.

8.5 The enclosure of a remotely or automatically controlled machine shall preclude molten metal, burning insulation, and flaming particles from falling on combustible materials, including the surface upon which the machine is supported.

8.6 The requirement in 8.5 will necessitate that an electrical component, such as, a switch, relay or solenoid, be individually and completely enclosed, except for terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the machine enclosure. It will also necessitate the use of a barrier of noncombustible material:

a) Under a motor unless:

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

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the machine when the motor is energized under each of the following fault conditions:

i) Open main winding,

ii) Open starting winding,

iii) Starting switch short-circuited, and

iv) Capacitor of permanent-split phase motor short circuited, the short-circuit is to be applied before the motor is energized and the rotor is to be locked;

3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will keep the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked; or

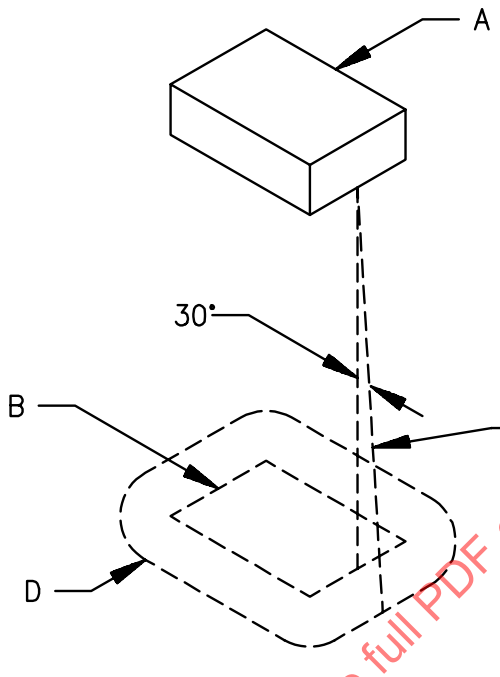
4) The motor complies with the requirements for impedance-protected motors, and the temperature of the motor winding will not exceed 150°C (302°F) during the first 72 hours of operation with the rotor of the motor locked.

b) Under wiring, unless it is neoprene- or thermoplastic-insulated.

8.7 The barrier mentioned in 8.6 shall be horizontal, shall be located as indicated in Figure 8.1, and shall not have an area less than that described in that illustration. Openings, such as drain holes and vent openings, may be employed in the barrier, provided such openings would keep molten metal and burning insulation from falling on combustible material.

Figure 8.1

Location and extent of barrier



NOTES:

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 that is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always:

a) Tangent to the component,

b) Five degrees from the vertical, and

c) So oriented that the area traced out on a horizotal plane is maximum.

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

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8.8 A door or a cover of an enclosure that provides access to any overload-protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner.

8.9 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight-fitting.

8.10 If the deterioration of a polymeric liquid container or breakage of a glass liquid container provided as part of a machine would result in a risk of fire or electric shock, the container shall be of a material that is compatible with the liquid intended to be used therein. See 10.2 for metallic liquid containers. A machine provided with a liquid container shall comply with the construction requirements in Liquid Mixing and Blending Machine, Section 29, and Flooding of Live Parts Tests, Section 41.

8.11 A cord-connected machine intended for mounting on a wall shall comply with the Adequacy of Mounting Test, Section 56.

9 Mechanical Assembly

9.1 A machine shall be assembled such that it will not be adversely affected by the vibration of normal operation. Compliance shall be determined by physical inspection performed after completion of the Normal Temperature Test, Section 36. Brush caps shall be tightly threaded or otherwise designed to preclude loosening.

9.2 A switch other than a through-cord switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be kept from turning. See 9.4.

Exception No. 1: A switch need not be precluded from turning if all four 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 normal operation of the switch.

b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it.

c) The spacings are not reduced below the minimum required values if the switch rotates.

d) The normal operation of the switch is by mechanical means rather than by direct contact by persons.

Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be precluded from turning if rotation cannot reduce spacings below the minimum required values.

9.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be kept from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum acceptable values.

9.4 The means for preventing the turning or shifting mentioned in 9.2 and 9.3 is to consist of more than friction between surfaces – for example, a properly applied lock washer is acceptable as the means for preventing a small stem-mounted switch, or other device having a single-hole mounting means, from turning.

10 Protection Against Corrosion

10.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means, if corrosion of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure are not required to be protected against corrosion if the oxidation of the metal due to the exposure to air and moisture is not likely to be appreciable. The thickness of metal and temperature are also to be considered.

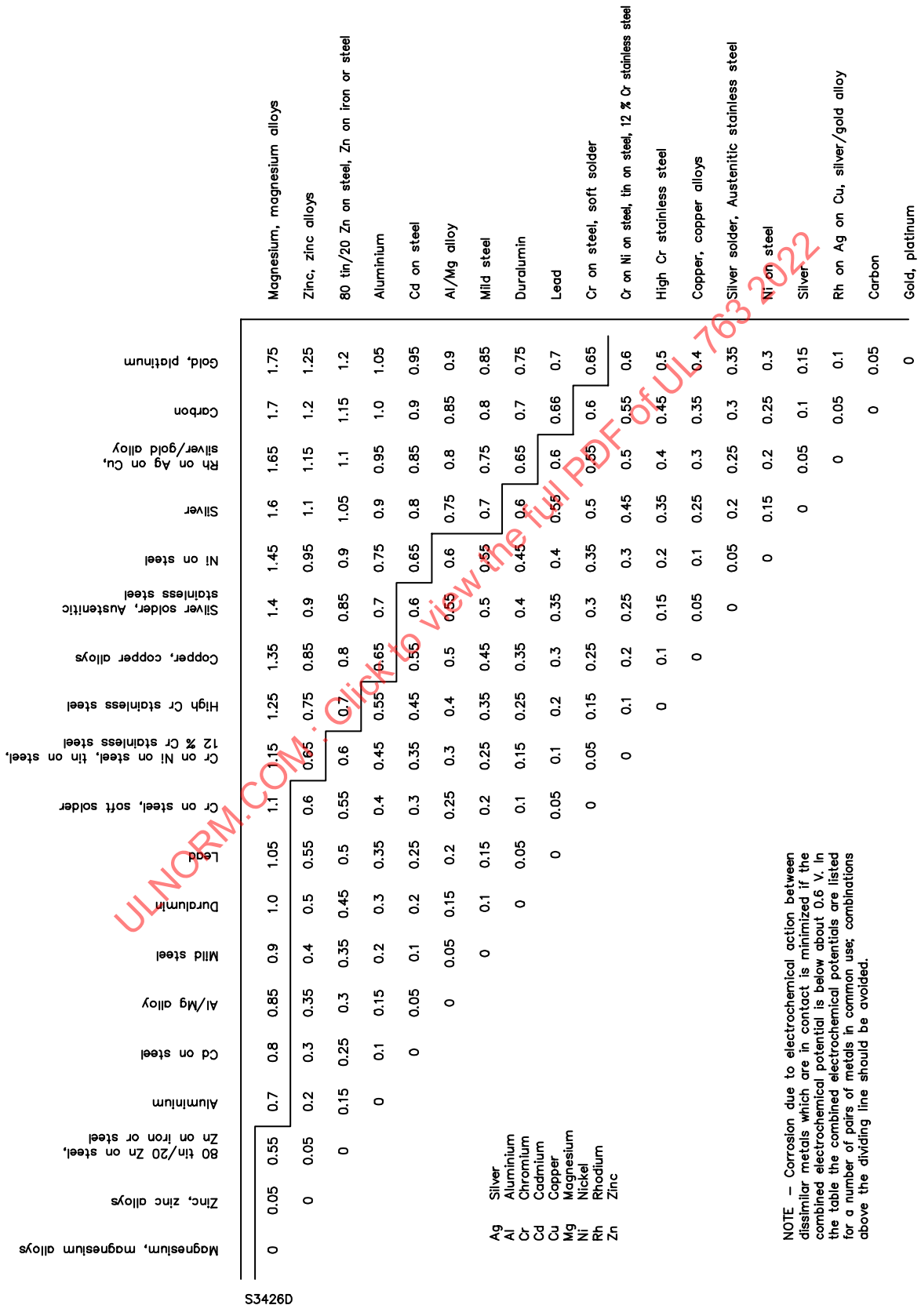
Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like need not comply with this requirement.

10.2 If deterioration of a liquid container provided as a part of a machine would result in a risk of fire or electric shock, the container shall be of a material that is resistant to corrosion by the liquid intended to be used therein. A machine provided with a liquid container shall comply with Liquid Mixing and Blending Machine, Section 29, and Flooding of Live Parts Tests, Section 41.

10.3 Metal shall be used in combinations that are galvanically compatible and shall not be subject to significant corrosion due to electrochemical action in any working, storage, or transport environmental conditions. Compliance is checked by inspection and by reference to Figure 10.1. Combinations above the line in the table shown in Figure 10.1 shall be avoided. Corrosion resistance may be achieved by a suitable plating or coating process.

Figure 10.1

Table of electrochemical potentials



NOTE – Corrosion due to electrochemical action between dissimilar metals which are in contact is minimized if the combined electrochemical potential is below about 0.6 V. In the table the combined electrochemical potentials are listed for a number of pairs of metals in common use; combinations above the dividing line should be avoided.

11 Accessibility of Live Parts

11.1 Electrical parts of a machine shall be located or enclosed so that protection against unintentional contact with uninsulated live parts is provided. Insulated brush caps do not require additional enclosure.

11.2 During the examination of a machine in connection with the requirements in 11.1, a part of the outer enclosure that may be removed without the use of tools by the user of the machine to permit the attachment of accessories, to allow access to means for making operating adjustments, or for another reason is to be disregarded – that is, it is not to be assumed that the part in question affords protection against the risk of electric shock.

11.3 An opening anywhere in the enclosure of a hand-supported machine or in any portion of a machine hand-held in normal use is acceptable if a probe as illustrated in Figure 11.1, when inserted point first as far as possible into the opening:

a) Does not enter the opening for a distance of more than 1/8 inch (3.2 mm), and

b) Does not touch any uninsulated live part or film-coated magnet wire.

11.4 In the enclosure of a machine other than as described in 11.3:

a) An opening that a 3/4-inch (19.1-mm) diameter rod will not enter is acceptable if:

1) A probe as illustrated in Figure 11.2 cannot be made to touch any uninsulated live part when inserted through the opening, and

2) A probe as illustrated in Figure 11.3 cannot be made to touch film-coated magnet wire when inserted through the opening.

b) An opening that a 3/4-inch (19.1-mm) diameter rod will enter is acceptable under the conditions described in 11.5 and Figure 11.4 .

Figure 11.1

Probe for hand-supported enclosure

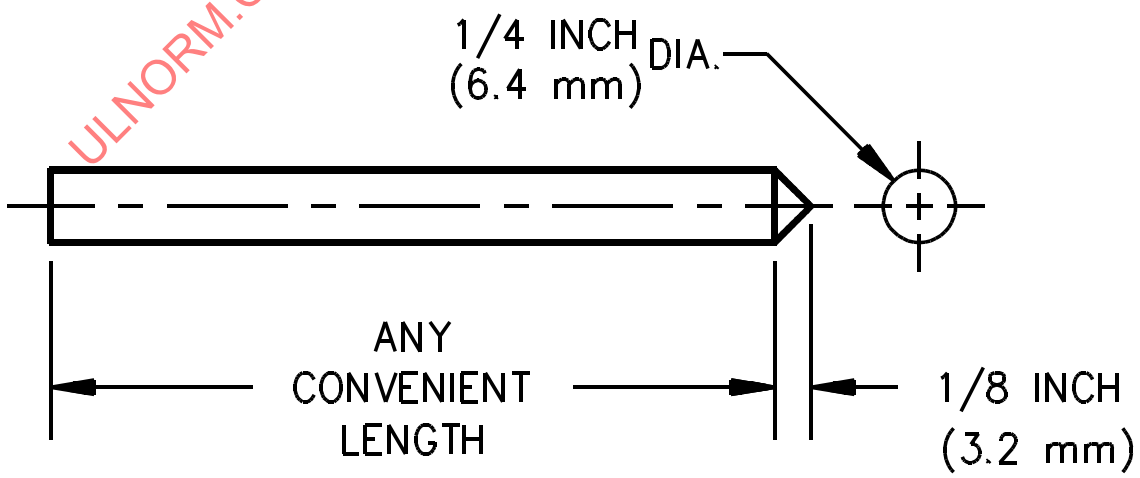


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Figure 11.2

Probe for uninsulated live part

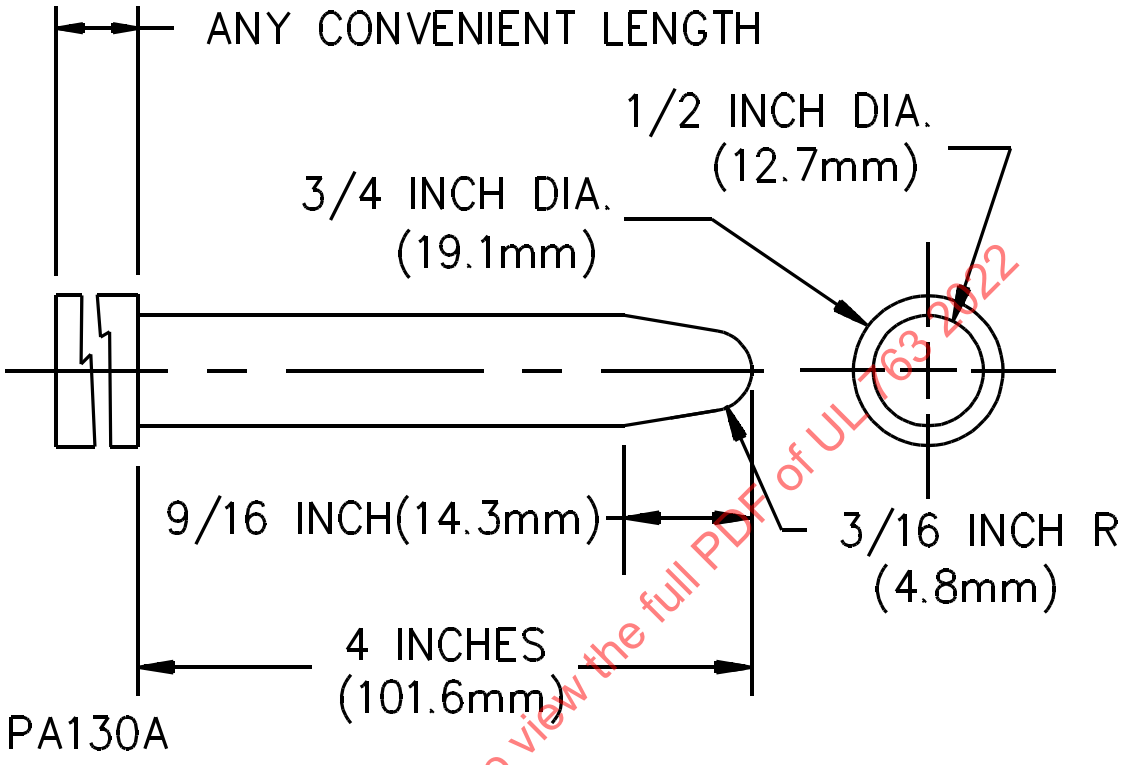


Figure 11.3

Probe for film-coated magnet wire

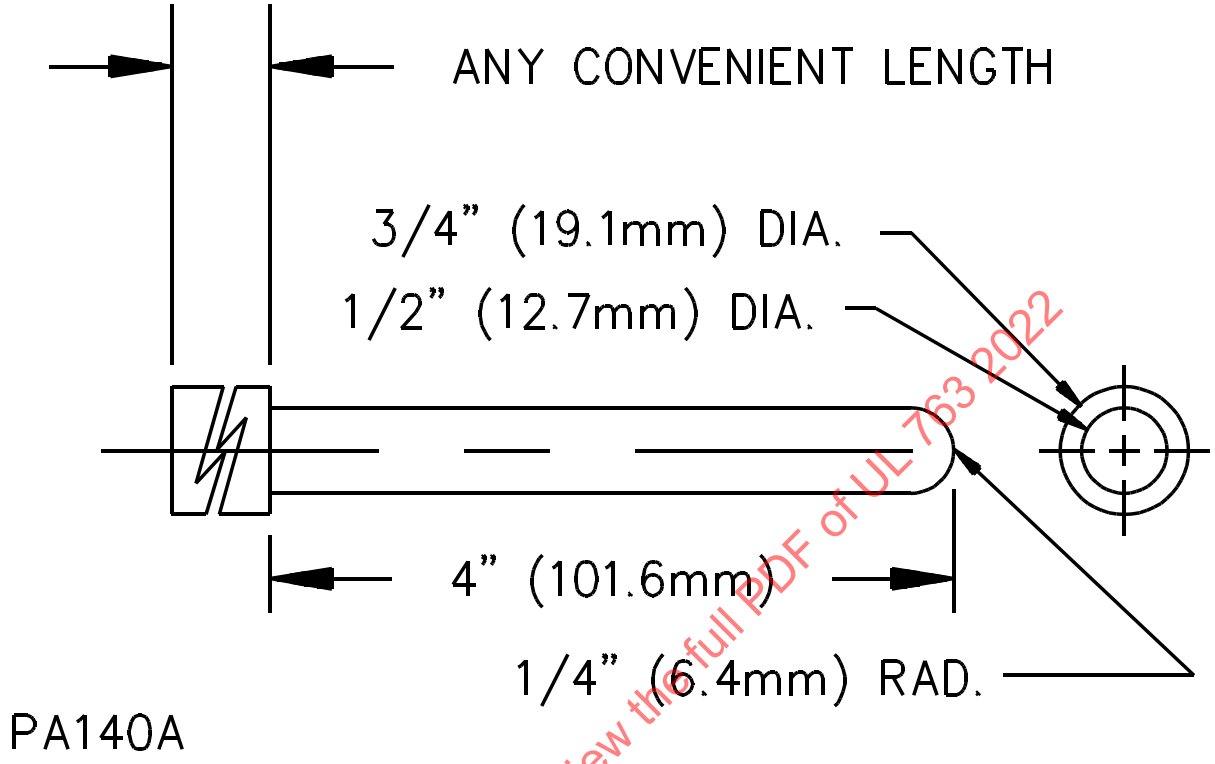
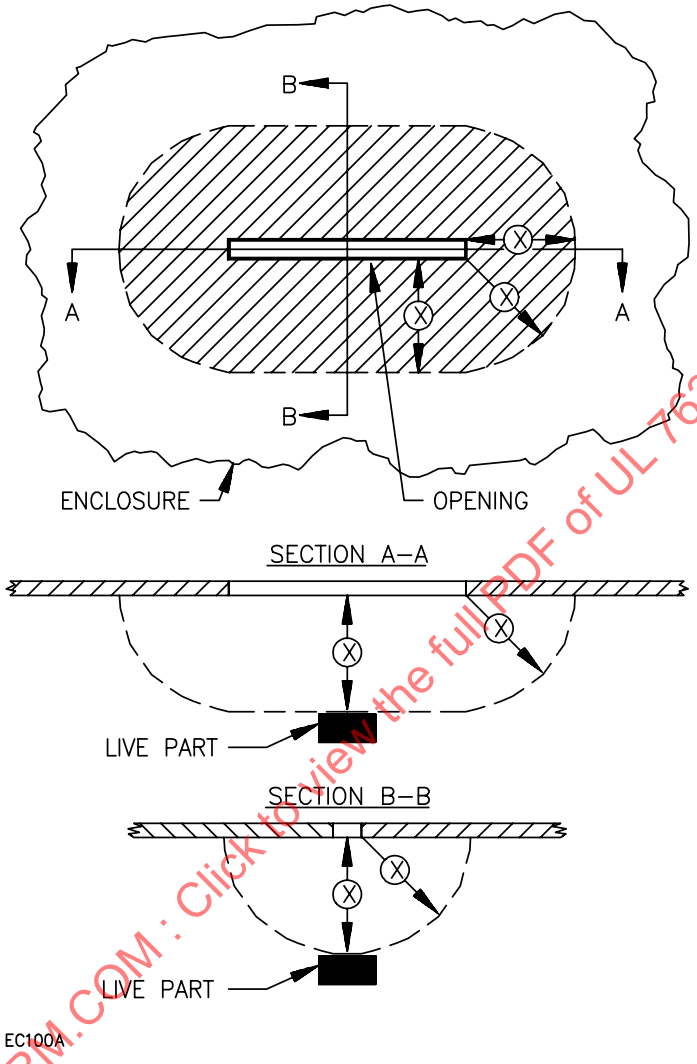


Figure 11.4

Opening in enclosure



11.5 The opening illustrated in Figure 11.4 is acceptable if, within the enclosure, there is no uninsulated live part or film-coated magnet wire less than X distance from the perimeter of the opening, as well as within the volume generated by projecting the perimeter distance X normal to its plane. X equals five times the diameter of the largest round rod that can be inserted through the opening, but not less than 4 inches (102 mm). In evaluating an opening, any barrier located within the volume is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

12 Supply Connections

12.1 Cord-connected machines

12.1.1 General

12.1.1.1 A machine intended to be connected to the power-supply circuit by means of a flexible cord shall be provided with a flexible cord and an attachment plug for connection to the supply circuit.

12.1.1.2 The flexible cord shall have a voltage rating not less than the rated voltage of the machine, and shall have an ampacity that is not less than the current rating of the machine.

12.1.1.3 The flexible cord shall be:

a) Type SJ or heavier cord,

b) Not less than 5 feet (1.52 m) long, and

c) Attached to the machine.

Exception: A machine that is not required to be provided with a grounding conductor may be provided with a separate detachable power-supply cord having means for connection to the machine and a length of not less than 5 feet (1.52 m).

12.1.1.4 A floor-supported machine intended to be installed in a dedicated location – that is one expected to be permanently wired – is acceptable if provided with not more than 8 feet (2.44 m) of Type S, SO, ST, or STO cord and an attachment plug for supply connection when there is a need to permit removal for maintenance and repair.

12.1.1.5 An oil-resistant cord is required if the machine is likely to be subjected to grease or oil.

12.1.1.6 The length of an attached flexible cord is to be measured from where it enters the machine to the face of the attachment plug. The length of a detachable power-supply cord includes the fittings.

12.1.1.7 The attachment plug shall have an ampacity that is not less than the current rating of the machine and a voltage rating equal to the rated voltage of the machine. If a machine is intended for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided with the machine shall be acceptable for the voltage for which the machine is connected when shipped from the factory. See 63.1.3.

12.1.1.8 If a machine incorporates a disconnecting means, such as a cord connector in the supply cord between the handle and the motor, the arrangement shall be such that no live parts will be exposed under normal conditions.

12.1.2 Strain relief

12.1.2.1 Strain relief shall be provided so that mechanical stress on a flexible cord will not be transmitted to terminals, splices, or interior wiring.

12.1.2.2 Push-back relief shall be provided to keep a flexible cord from being pushed into a machine through a cord-entry hole if such displacement may subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is acceptable, or may reduce a spacing, such as to a metal strain-relief clamp, below the minimum acceptable value, or to cause movement of internal wiring at splices and terminals.

12.1.2.3 If a knot in a flexible cord serves as strain relief, a surface that the knot may contact shall be free from projections, burrs, fins, and other sharp edges that may cause abrasion of the insulation on the conductors.

12.1.2.4 The flexible cord shall be restrained from any rotation that will cause movement of internal wiring at splices and terminals.

12.1.3 Bushings

12.1.3.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be substantial, reliably secured in place, and shall have a smooth, well-rounded surface against which the cord may bear.

12.1.3.2 A vulcanized fiber bushing shall not be less than 3/64 inch (1.2 mm) thick and so formed and secured in place that it will not be adversely affected by conditions of ordinary moisture.

12.1.3.3 A separate soft-rubber, neoprene, or polyvinyl chloride bushing shall not be employed.

Exception No. 1: A separate soft-rubber, neoprene, or polyvinyl chloride bushing may be employed in the frame of a motor or in the enclosure of a capacitor attached to a motor provided that:

a) The bushing is not less than 3/64 inch (1.2 mm) thick, and

b) The bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substances having a deleterious effect on the compound employed.

Exception No. 2: A bushing of one of these materials may be used, if the edges of the hole in which the bushing is mounted are smooth and free from burrs, fins, and other sharp edges.

12.1.3.4 At any point in a machine, a bushing of the same material as, and molded integrally with, the supply cord is acceptable if the built-up section is not less than 1/16 inch (1.6 mm) thick at the point where the cord passes through the enclosure.

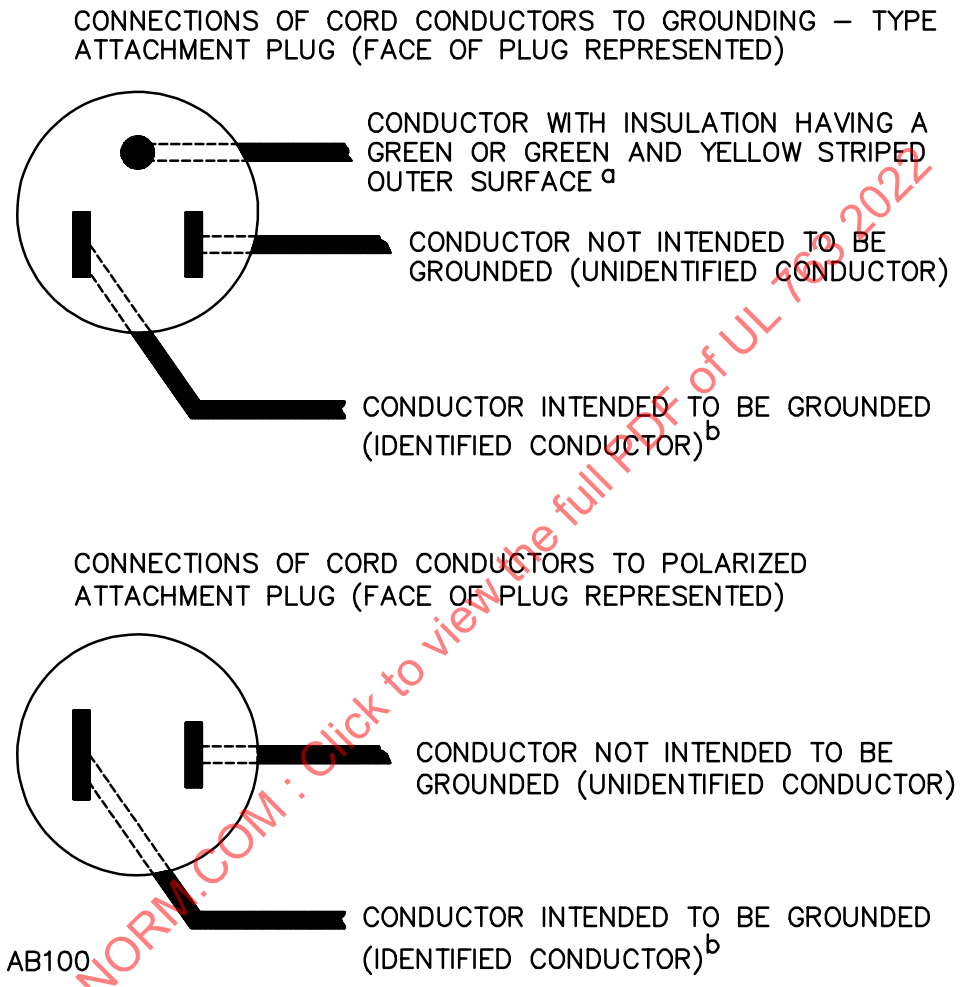
12.1.4 Polarization

12.1.4.1 The attachment plug of the power-supply cord of a machine with a nominal 120-volt rating and provided with a manually operated, line-connected, single-pole switch for appliance on-off operation, or an Edison-base lampholder, shall be of the 2-wire polarized or 3-wire grounding type. The attachment plug of the power-supply cord of a machine provided with a 15- or 20-ampere general-use receptacle shall be of the 3-wire grounding type.

12.1.4.2 If a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connections shall comply with Figure 12.1 and the polarity identification of the flexible cord shall comply with Table 12.1 .

Figure 12.1

Connection to attachment plug



[a] The blade to which the green conductor is connected may have a U-shaped or circular cross section.

[b] Signifies a conductor identified in accordance with Table 12.1 .

Table 12.1
Polarity identification of flexible cords

Method of identification	Acceptable combinations	
	Conductor intended to be grounded[a]	All other conductors[a]
Color of braids on individual conductors	Solid white or grey – without tracer	Solid color other than white or grey – without tracer
	Color other than white or grey, with tracer in braid	Solid color other than white or grey – without tracer
Color of insulation on individual conductors	Solid white or grey[b]	Solid color other than white or grey[b]
	Light blue	Solid color other than light blue, white, or grey
Color of separators	White or grey	Color other than white or grey

[a] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor.

[b] Only for cords having no braid on any individual conductor.

12.1.4.3 A machine employing a polarized detachable power-supply cord shall not accommodate a non-polarized cord.

12.2 Permanently connected machines

12.2.1 General

12.2.1.1 A machine intended for permanent connection to the power supply shall have provision for connection of one of the wiring systems that would be acceptable for the machine.

12.2.2 Terminal compartment

12.2.2.1 A terminal box or compartment in which power-supply connections to a permanently connected machine are to be made shall be provided and located so that the connections may be readily inspected after the machine is installed as intended.

12.2.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the machine so as to be kept from turning.

12.2.2.3 If it is intended that supply connections be made directly to a motor, the terminal compartment on the motor shall comply with the requirements for terminal compartments in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

12.2.2.4 An electrical component shall not be mounted on a part, such as the cover of a terminal compartment, that must be removed to make or inspect field-wiring connections.

12.2.3 Wiring terminals and leads

12.2.3.1 A permanently connected machine shall be provided with wiring terminals for the connection of conductors having an ampacity acceptable for the machine; or the machine shall be provided with leads for such connection.

12.2.3.2 A field-wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless the wire and a means of making the connection – a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, or the equivalent – are factory-assembled to the wire and provided as a part of the machine.

12.2.3.3 Wiring terminals for the supply conductors – excluding the grounding conductor – shall be provided with a pressure wire connector securely fastened in place, for example, firmly bolted or held by a screw.

Exception No. 1: A soldering lug may be used.

Exception No. 2: A wire binding screw or stud-and-nut combination may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in place.

12.2.3.4 A wiring terminal shall be kept from turning.

12.2.3.5 A lead intended for field connection to an external circuit shall:

a) Have a free length of 6 inches (150 mm) or more, and

b) Not be more than two sizes smaller than the external circuit conductor to which it is intended to be connected.

Exception: The lead may be less than 6 inches (150 mm) long if it is evident that the use of a longer lead might result in a risk of fire or electric shock.

12.2.3.6 A wire-binding screw or stud-and-nut combination at a wiring terminal shall not be smaller than No. 10 and shall thread into metal.

Exception No. 1: A No. 8 screw or stud may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) or smaller conductor.

Exception No. 2: A No. 6 screw or stud may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm^2) conductor.

12.2.3.7 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick and shall not have less than two full threads in the metal.

Exception: An alloy plate may be not less than 0.030 inch (0.76 mm) thick if the tapped threads have adequate mechanical strength.

12.2.3.8 A terminal plate formed from stock having the thickness specified in 12.2.3.7 may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

12.2.3.9 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size specified in 12.2.3.1 under the head of the screw or washer.

12.2.4 Grounded terminals and leads

12.2.4.1 A permanently connected machine nominally rated 120 or 120/240 V (3-wire) and employing a lampholder of the Edison-screw-shell type, 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.

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

12.2.4.3 A lead intended for the connection of a grounded power-supply conductor shall be finished white or grey color and shall be readily distinguishable from the other leads.

13 Current-Carrying Parts

13.1 A current-carrying part shall be of silver, copper, a copper alloy, stainless steel, or other similar metal.

13.2 Ordinary iron or steel shall not be used as a current-carrying part.

Exception: Ordinary iron or steel provided with a corrosion-resistant coating, may be used for a current-carrying part if acceptable in accordance with 6.1.1.

14 Insulating Material

14.1 Material for mounting an uninsulated live part shall be porcelain, phenolic composition, or other equivalent material.

14.2 Thermoplastic material in direct contact or close proximity to live parts, other than magnet wire, shall have physical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric strength, and other properties appropriate for the application as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

14.3 Ordinary vulcanized fiber, minimum 1/32 inch (0.8 mm) thick, may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock.

14.4 Small molded parts, such as brush caps, terminal blocks, shall be constructed to have the necessary mechanical strength and rigidity to withstand the stresses of actual service. Brush caps shall be secured or located so that they are protected from mechanical damage that might result during intended use.

15 Internal Wiring

15.1 Mechanical protection

15.1.1 Wiring and connections between parts of a machine shall be protected or enclosed.

Exception: A length of flexible cord may be employed for external connection if flexibility is essential.

15.1.2 Wires shall be routed or otherwise protected so that damage to conductor insulation cannot result from contact with any rough, sharp, or moving part.

15.1.3 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure of a machine shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces upon which the wires may bear.

15.1.4 A flexible cord used for external interconnection as mentioned in 15.1.1 shall be provided with strain relief and bushings in accordance with the requirements in 12.1.2.1 – 12.1.3.3 and the Strain Relief Test, Section 51, unless the construction is such that the cord will be protected from stress and motion.

15.1.5 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of a machine.

15.1.6 Internal wiring shall consist of wires of a type or types that are acceptable for the application. Temperature, voltage and exposure to oil, grease, or other conditions of service to which it is likely to be subjected are to be considered.

15.1.7 With reference to exposure of insulated wiring through an opening in the enclosure of a machine, the protection of such wiring required by 15.1.1 is considered to exist if, when considered as though it were film-coated magnet wire, the wiring would be acceptable according to 11.3 and 11.4. Internal wiring not so protected may be accepted if it is secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

15.1.8 Wiring that may be located in proximity to combustible material or may be subjected to mechanical damage shall be in armored cable, rigid metal conduit, electrical metallic tubing, metal raceway, or be otherwise equivalently protected.

15.1.9 Where the normal operation, cleaning, user servicing or installation of an appliance causes movement of the internal wiring, the Wiring Flexing Test of Section 50 shall be conducted unless the wiring is located in a low-voltage circuit the functioning of which is not relied upon for compliance with this standard.

15.2 Splices and connections

15.2.1 Each splice and connection shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be mechanically secured before being soldered if breaking or loosening of the connection may result in a risk of fire or electric shock.

15.2.2 For a machine in which excessive vibration is likely to occur, the requirement in 15.2.1 will necessitate the use of lockwashers or other equivalent means to prevent wire-binding screws and nuts from becoming loosened.

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

15.2.4 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for internal connection between current-carrying parts or as motor windings, shall be terminated by a method acceptable for the combination of metals involved at the point of connection.

15.2.5 With reference to the requirements in 15.2.4, a wire-binding screw or a pressure wire connector used as a terminating device shall be acceptable for use with aluminum conductors under the conditions involved – for example, temperature, heat cycling and vibration, as determined by compliance with the applicable requirements in the Standard for Wire Connectors, UL 486A-486B.

15.2.6 Insulation consisting of two layers of friction tape, two 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 V. In determining if splice insulation consisting of coated-fabric, thermoplastic or other type of tubing is acceptable, consideration is to be given to such factors as its dielectric properties, heat-resistant and moisture-resistant characteristics. Thermoplastic tape wrapped over a sharp edge is not acceptable.

15.2.7 If stranded internal wiring is connected to a wire-binding screw, loose strands of wire shall be kept from contacting other uninsulated live parts that are not always of the same polarity as the wire and from contacting dead metal parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other equivalent means.

16 Grounding

16.1 General

16.1.1 The following types of machines shall have provision for grounding:

a) A machine for use in damp or wet locations,

b) A machine intended to be used on a circuit operating at more than 150 V to ground,

c) A machine intended for permanent connection to the supply source, and

d) A hand-held machine that is partially immersed in liquid during normal use, for example, a wand-type mixer.

16.1.2 With reference to 16.1.1(b), a two-wire machine intended to operate at a nominal potential of 240 V and any other potential greater than 150 V, is to be provided with means for grounding in accordance with 16.1.4 and 16.1.5 unless the marked rating on the machine is 120/240 V or the machine is otherwise marked to indicate that it is to be connected to a circuit operating at 150 V or less to ground.

16.1.3 If a provision for grounding is provided, it shall be in accordance with 16.1.4, and if the machine is cord connected shall comply with the requirements in 16.1.5. All exposed dead metal parts and all dead metal parts within the enclosure that are exposed to contact during any user servicing operation, and are likely to become energized, shall be reliably connected to the means for grounding. The suitability of the grounding means shall be determined by the grounding test specified in Section 59A, Grounding Continuity Test.

Exception: A dead-metal part within the enclosure where it is not exposed during user servicing need not be grounded, provided the appliance is marked in accordance with 63.4.8.

16.1.4 The following are acceptable means for grounding:

a) In a machine intended to be permanently connected by a metal-enclosed wiring system, a knockout or equivalent opening in the metal enclosure of the machine.

b) In a machine intended to be permanently connected by a nonmetal-enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead. See 16.1.9 and 63.2.3.

c) In a cord-connected machine, an equipment-grounding conductor in the cord.

16.1.5 The grounding conductor of a supply cord shall be secured to the frame or enclosure of the machine by means of a screw that is not likely to be removed during any servicing operation not involving the power-supply cord, or by other equivalent means. Solder alone shall not be used for securing the grounding conductor. Servicing as mentioned in this paragraph includes repair of the machine by a qualified serviceman.

16.1.6 The grounding conductor of a cord-connected machine shall be connected to the grounding member of an attachment plug. The grounding member shall be fixed.

16.1.7 A separable connection, such as that provided by a plug and a mating connector or receptacle, shall be such that the equipment-grounding connection is made before connection to and broken after disconnection from the supply conductors.

Exception: Interlocked plugs, receptacles, and connectors that are not energized when the equipment-grounding connection is made or broken need not comply with this requirement.

16.1.8 If a machine is intended to be grounded and is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

16.1.9 A field-wiring terminal solely for the connection of an equipment-grounding conductor shall be capable of securing a conductor of the size necessary for the application. A connection device that depends on solder alone, such as a solder lug, shall not be provided for connecting the equipment-grounding conductor.

16.1.10 A wire-binding screw or pressure wire connector intended for the connection of an equipment-grounding conductor shall be located so that it is unlikely to be removed during normal servicing of the machine.

16.1.11 A machine marked as being provided with double insulation shall not be provided with a means for grounding.

16.2 Grounding identification

16.2.1 The surface of the insulation of a grounding conductor of a flexible cord shall be green with or without one or more yellow stripes.

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

16.2.3 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal or slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G", "GR", "Ground", "Grounding", or the equivalent, or by a marking on a wiring diagram provided on the machine.

17 Spacings

17.1 Other than at field-wiring terminals, the spacing between uninsulated 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 be grounded shall not be less than the value specified in Table 17.1 .

Exception No. 1: The acceptability of the inherent spacings of a component of the machine, such as a snap switch and a motor, is based on the requirements for the component in question.

Exception No. 2: For an isolated dead metal part, spacings may comply with 17.4.

Table 17.1
Minimum acceptable spacings at other than field-wiring terminals

Potential involved, volts	Machine employing a motor having a diameter of 7 inches (178 mm) or less[a]		Machine employing a motor having a diameter more than 7 inches (178 mm)[a]	
	Over surface	Through air	Over surface	Through air
0 – 125	3/32 (2.4)[c]	3/32 (2.4)[c]	1/4 (6.4)[b]	1/8 (3.2)[b]
126 – 250	3/32 (2.4)	3/32 (2.4)	1/4 (6.4)[b]	1/4 (6.4)[b]
251 – 600	1/2 (12.7)[b]	3/8 (9.5)[b]	1/2 (12.7)[b]	3/8 (9.5)[b]

[a] This is the diameter, measured in the plane of a lamination, of the circle circumscribing the stator frame, excluding lugs, fins, boxes and other protrusions used solely for motor, cooling, assembly, or connection.

[b] A spacing of not less than 3/32 inch (2.4 mm), over surface and through air, is acceptable between film-coated magnet wire, rigidly supported and held in place on a coil, and a dead metal part.

[c] For a motor rated at 1/3 hp or less, these spacings shall not be less than 1/16 inch (1.6 mm).

17.2 If an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the required minimum spacing will be maintained.

17.3 In a machine incorporating two or more motors of different sizes, the acceptability of the spacings inside each motor is to be based on the size of that motor, and the acceptability of the spacings elsewhere in the machine is to be based on the size of the largest motor in the machine.

17.4 If an isolated dead metal part is interposed between or is in close proximity:

a) To live parts of opposite polarity,

b) To a live part and an exposed dead metal part, or

c) To a live part and a dead metal part that may be grounded,

the spacing may be not less than 3/64 inch (1.2 mm) between the isolated dead metal part and any one of the other parts previously mentioned, provided the total spacing between the isolated dead metal part and the two other parts is not less than the value specified in Table 17.1 .

17.5 An insulating lining or barrier of vulcanized fiber or similar materials employed where spacing would otherwise be insufficient 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, except that 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 spacing required for air alone.

Exception: Thinner insulating material may be used, if upon investigation, it is found to be acceptable for the application.

17.6 All uninsulated live parts connected to different line-voltage or low-voltage circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirements in 17.1 and 17.8 and shall be judged on the basis of the highest voltage involved.

17.7 The spacing between uninsulated live parts of opposite polarity and between such parts and dead metal that may be grounded in service is not specified for parts of low-voltage circuits.

17.8 The spacing between field-wiring terminals of opposite polarity, and the spacing between a wiring terminal and any other uninsulated metal part – dead or live – not of the same polarity, shall not be less than that specified in Table 17.2 . See 12.2.3.2.

Table 17.2
Minimum acceptable spacings at field-wiring terminals

Potential involved, volts	Minimum spacing, inch (mm)[a]		
	Between field-wiring terminals, through air or over surface	Between a field-wiring terminal and a dead metal part of an uninsulated live part not always of the same polarity	
		Over surface	Through air
250 or less	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
More than 250	1/2 (12.7)	1/2 (12.7)	3/8 (9.5)

[a] Applies to the sum of the spacings involved where and isolated dead metal part is interposed.

17.9 At terminal screws and studs to which connection may be made in the field by means such as wire connectors and eyelets as described in 12.2.3.2, spacings shall not be less than those specified in Table 17.1 when such terminations are positioned such that minimum spacings– opposite polarity and to dead metal – exist.

17.10 An expansion type protected capacitor shall have additional through-air expansion spacings in the axial direction to allow for movement of the terminals. The additional expansion spacing shall be at least 12.7 mm (1/2 inch) through air in addition to the applicable electrical spacings.

18 Alternate Spacings – Clearances and Creepage Distances

18.1 As an alternative to the specified spacing requirements in Spacings, Section 17, the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, may be used. The spacing requirements in UL 840 shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure. In determining the pollution degree and overvoltage category, the end-use application is to be considered and may modify those characteristics given in 18.2 – 18.5.

18.2 When applying specific requirements in UL 840, it is anticipated that the degrees of pollution expected or controlled will be as indicated in Table 18.1.

Table 18.1
Degrees of pollution

Equipment	Pollution degree
Hermetically sealed or encapsulated equipment or printed wiring boards with protective coating.[a]	1
Equipment for ordinary locations and indoor use, such as residential controls, commercial controls for use in a clean environment, nonsafety controls for installation on or in machines.	2
All safety or limit controls, equipment for outdoor use, and equipment influenced by surrounding environment, such as industrial controls, refrigeration controls, and water heater controls.	3

[a] Tested in accordance with the protective coating test in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

18.3 When applying specific requirements in UL 840, it is anticipated that the equipment will be identified by overvoltage categories as indicated in Table 18.2 .

Table 18.2
Overvoltage categories

Equipment	Overvoltage category
Intended for fixed wiring connection	III
Portable and stationary cord-connected	II
Power-limited and safety[a] low voltage	I
[a] Applicable to low-voltage circuits if a short circuit between the parts involved may result in operation of the controlled equipment that would increase the likelihood of a risk of fire or electric shock.	

18.4 In order to evaluate clearances where the levels of overvoltage are controlled, control of overvoltage shall be achieved by providing an overvoltage device or system as an integral part of the product. The equipment shall be evaluated for the rated impulse withstand voltage specified in UL 840.

18.5 Printed wiring boards constructed of Types XXXP, XXXPC, G-10, FR-2, FR-3, FR-4, FR-5, CEM-1, CEM-3, GPO-2, or GPO-3 industrial laminates in accordance with the Standard for Polymeric Material – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E, are considered to have a minimum comparative tracking index of 100 without further investigation.

19 Flooding of Live Parts

19.1 A counter-top machine, such as a blender, shall preclude the drawing or overflow of liquids into the motor of the machine if such action would result in a risk of fire or electric shock. See Flooding of Live Parts Tests, Section 41.

19.2 The malfunction of a timer switch or of a float- or pressure-operated switch, or the deterioration or damage of a boot or diaphragm of rubber or similar material shall not cause flooding of the electrical components of a machine that employs water or other electrically conductive liquid in its operation. Compliance shall be determined by the Test for Deterioration of Parts Subject to Flexing, Section 44, and the Test for Parts Not Subject to Flexing, Section 45, as applicable.

20 Air Filters

20.1 A machine incorporating an air filter over ventilation openings shall be evaluated to determine the effects of a partially or completely blocked air filter. See 36.1.9 and 54.1.

20.2 Air filters shall not be located within the electrical enclosure of the machine and shall be located such that propagation of flame from one area to another or bridging between a possible source of ignition and other ignitable parts is unlikely.

20.3 An air filter intended to be replaced or cleaned by the user shall be readily visible and replaceable without making accessible live parts or mechanical parts that may cause injury to persons. The machine shall be provided with instructions as specified in 65.1 for replacement or cleaning of the filter.

20.4 An air filter not intended to be replaced or cleaned by the user need not be readily visible or accessible and the instructions of 65.1 need not be provided if the machine complies with the Normal Temperature Test with the filter completely (100%) blocked.

PROTECTION AGAINST INJURY TO PERSONS

21 General

21.1 If the operation, cleaning and maintenance of a machine by the user involves the risk of injury to persons, protection shall be provided to minimize the risk.

21.2 When determining compliance with respect to the requirement in 21.1 consideration shall be given to reasonably foreseeable misuse of the machine.

21.3 A functional attachment that is made available or is recommended by the manufacturer for use with the basic machine shall be included in the evaluation of the machine. Unless the manufacturer recommends the use of two or more attachments at the same time, only one attachment at a time is to be evaluated with the machine.

21.4 The adequacy of a part provided to reduce the risk of injury to persons, such as a guard, a safety release, or an interlock, and whether such a device is required, are to be determined by evaluating the complete machine, its operating characteristics, and the likelihood of a risk of injury to persons resulting from any reasonably foreseeable misuse. See 28.7.

21.5 Specific constructions, tests, markings, and guards are detailed for some common constructions. Specific features and machines not covered herein are to be examined and tested to determine whether they are acceptable for the purpose.

22 Sharp Edges

22.1 An enclosure, a frame, a guard, a handle, or other accessible parts shall not be sufficiently sharp so as to constitute a risk of injury to persons in normal maintenance and use.

Exception: This requirement does not apply to a part or portion of a part needed to perform a working function.

22.2 Whenever referee measurements are necessary to determine that a part as mentioned in 22.1 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be employed.

23 Enclosures and Guards

23.1 The rotor of a motor, a pulley, a belt, a gear, or other moving part that could cause injury to persons shall be enclosed or guarded to reduce the likelihood of unintentional contact therewith.

Exception: A part or portion of a part that is necessarily exposed to perform the work function need not be enclosed but, when necessary, guarding shall be provided. See 23.4.

23.2 The degree of protection required of the enclosure in 23.1 depends upon the construction and intended use of a machine.

23.3 A moving part that may involve a risk of injury to persons shall be considered with respect to:

a) The degree of exposure necessary to perform the intended function;

b) The sharpness of the moving part;

c) The likelihood of unintentional contact with the moving part;

d) The speed of the moving part; and

e) The likelihood:

1) That a part of the body could be endangered or

2) That clothing could be entangled, resulting in a risk of injury to persons.

The above factors are to be considered with respect to both intended operation of the machine and reasonably foreseeable misuse.

23.4 Some guards are required to be of the self-restoring type. Other features of guards that are to be considered include:

a) Removability without the use of tools;

b) Removability for servicing;

c) Strength and rigidity;

d) Completeness; and

e) Creation of additional risk of injury to persons such as pinch points, and the necessity for additional handling because of the increased need for servicing, such as for cleaning and unjamming.

23.5 A feeding mechanism, either manual or automatic, shall be constructed or guarded to reduce the likelihood of or necessity for fingers of the operator to be in an area in which they could be injured.

23.6 A pusher or the like shall be provided if continuous manual feeding of a machine is necessary.

23.7 The drive mechanism of a machine shall be guarded so that no moving part, such as a pulley, belt, or gear, is exposed to unintentional contact. An opening in a guard or enclosure around a moving part shall not be more than 3/8 inch (9.5 mm) wide.

23.8 A cutting or slicing mechanism shall be guarded.

Exception: That portion of the blade or equivalent part where exposure is necessary for the cutting or slicing operation need not comply with this requirement.

23.9 For a manual feeding mechanism, a hopper or a tubular feed complies with the requirements in 23.5 if:

a) One-half the sum of the maximum and minimum dimensions of the throat of the hopper or opening of the tube is not more than 2-1/2 inches (64 mm), and

b) The cutters are recessed below the plane of the throat or opening.

24 Materials

24.1 The material of a part – such as an enclosure, a frame, or a guard – the breakage or deterioration of which might result in a risk of injury to persons shall have such properties as to meet the demand of expected loading conditions.

24.2 The requirement in 24.1 applies to those portions of a part adjacent to a moving part considered to involve a risk of injury to persons.

25 Rotating or Moving Members

25.1 A rotating or moving part that, if it should become disengaged, may create a risk of injury to persons shall be provided with a means to retain the part in place under conditions of use.

25.2 A rotating member, the breakage of which may create a risk of injury to persons, shall be constructed so as to reduce the likelihood of its breakage, or the release or loosening of a part, that could become a risk of injury to persons. See the Overspeed Test, Section 40.

26 Parts Subject to Pressure

26.1 A pressure vessel having an inside diameter more than 6 inches (152 mm), subjected to a pressure more than 15 pounds per square inch gauge (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 not less than the pressure determined in accordance with 26.3.

26.2 A pressure vessel, because of its application, not covered by the scope of the inspection procedure of the ASME code shall be designed and constructed so that it will comply with requirements in 26.3.

26.3 A part or an 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 not more than five times the marked maximum supply pressure from an external source and not more than five times the pressure setting of a pressure-relief device provided as a 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 not less than the value specified in Table 26.1.

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

Table 26.1
Wall thickness for copper and steel tubing

Outside diameter		Minimum wall thickness		Maximum pressure to which tubing is subjected, PSIG [Megapascals (MPa)]		
Inch	(mm)	Inch	(mm)	Seamless copper	Butt-welded steel	Seamless steel
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)
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)

26.4 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 47.1 when tested at a pressure equal to five times the maximum pressure capable of being developed in the system.

27 Pressure Relief Devices

27.1 A means for relieving pressure shall be provided for a part in which pressure might be generated by an external source of heat.

27.2 A pressure-relief device, a fusible plug, a soldered joint, nonmetallic tubing, or other equivalent pressure-relief means may be employed to comply with the requirements in 27.1.

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

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

27.5 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 machine shall be protected by a pressure-relief device.

27.6 The start-to-discharge pressure setting of a pressure-relief device shall not be higher than the working pressure marked on the vessel. The discharge rate of the device shall be adequate to relieve the pressure.

27.7 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.

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

27.9 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 prevent the pressure from exceeding 90 percent of the relief device setting under any condition of normal operation.

28 Switches, Controls, and Interlocks

28.1 A machine shall be constructed so as to reduce the risk of unexpected operation of a part capable of causing injury to persons.

28.2 Each function of a multiple-function machine is to be taken into consideration in determining whether the machine complies with the requirements in 28.1.

28.3 If, when energized, a machine has a moving part that is likely to cause injury to persons – a motor control switch, other than a momentary-contact switch, on the machine shall have a plainly identified OFF position, or ON and OFF positions.

a) The OFF position of the switch shall be marked with either one or both of the following:

1) The word "OFF", or its equivalent (for example, "STOP"), or

2) The symbol shown in Figure 28.2.

b) The ON position of the switch, when identified, shall be marked with one or both of the following, as determined by the marking of the OFF position of the switch:

1) The word "ON", or its equivalent (for example, "START"), when the OFF position of the switch is marked with the word "OFF", or its equivalent (for example, "STOP"), or

2) The symbol shown in Figure 28.1, when the OFF position of the switch is marked with the symbol shown in Figure 28.2.

When only the symbols shown in Figure 28.1 and Figure 28.2 are used, the significance of these symbols shall be explained in the instructions provided with the machine.

Figure 28.1

Symbol for ON position

IEC 417, Symbol 5007

Figure 28.2

Symbol for OFF position

IEC 417, Symbol 5008

28.4 If unintentional operation of a switch can result in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation is unlikely.

28.5 A device that automatically starts a machine, such as a timer or an automatically reset overload-protective device, shall not be employed unless it can be demonstrated that automatic starting will not result in a risk of injury to persons.

28.6 The requirement in 28.5 will necessitate the use of an interlock if there is a risk of injury to persons upon the automatic starting or restarting of the motor.

28.7 When a malfunction or breakdown of an electronic component located in any circuit of the product results in increased risk of injury to persons, such as loss of "off" control or unexpected operation, that circuitry shall be investigated for reliability in accordance with The Evaluation of Electronic Circuits, Supplement SA of this Standard, or the Standard for Automatic Electrical Controls – Part 1: General

Requirements, UL 60730-1. A single malfunction is to be considered one at a time unless one event contributes to another. See 6.4, 28.3 and 63.4.5.

Exception: An appliance employing exposed moving parts and electronic controls with a "STOP" position, where a single malfunction of a component can cause unexpected operation, shall be provided with a motor control OFF switch in accordance with 28.3 and be constructed with a warning light which is visible to the user during operation and illuminated or flashing only when the appliance is energized and when the motor is in a stop condition but not OFF. See also 63.4.6.

29 Liquid Mixing and Blending Machine

29.1 The risk of injury to persons resulting from the operation of a liquefier or liquid mixer that employs a container of glass or similar breakable material shall be reduced, such as by the use of tempered glass.

29.2 If a blender jar is provided with a cutting assembly intended to be removed by the user, the construction shall be such that the jar will not disengage from the cutting assembly during intended operation.

29.3 To determine whether a construction complies with the requirements in 29.2 the jar assembly is to be placed on the base in any intended position in which the machine will operate.

29.4 An open-top blender jar shall be provided with a one- or two-piece cover, with a center opening. For a one-piece cover or the largest cover of a two-piece cover, the center opening shall not have a dimension larger than 2-5/8 inches (66.7 mm) or less than 1 inch (25.4 mm).

Exception No. 1: The cover opening may be located other than in the center of the cover if:

a) The cover is marked in accordance with 63.6.1.2, or

b) The blender complies with the Blender Cover Opening Splash Test of Section 43.

Exception No. 2: A one-piece cover may be provided without a center opening if the two warning markings in accordance with 63.6.1.3 are present on the cover.

30 Blenders Provided with a Capacitive Touch-Screen

30.1 Unless provided with a reliable cover interlock or a closed-top blender container, a blender with a capacitive touch screen shall be constructed to reduce the risk of unintentional operation of the blender. The touch screen shall be:

a) Provided with a flashing light, warning marking of 63.4.7, and instructions as specified in 65.3, when a single touch is needed to initiate operation of the blender;

b) Recessed or guarded (See 30.2); or

c) Provided with a two-step operation as specified in 30.3.

30.2 The touch screen is considered to be recessed or guarded to reduce the risk of unintentional operation if a cylindrical rod, having a diameter of 1.58 inches (40 mm) and a hemispherical end, applied to the touch screen with the blender in any stand-by mode is unable to contact the touch screen in an area that would initiate operation of the blender.

30.3 A blender touch screen provided with a two-step ON operation to reduce the risk of accidental operation as specified in 30.1 shall require two separate actuations to start operation of the blender and be provided with:

a) A plainly identified one-step OFF or STOP function (See also 28.3);

b) An indicator light or other visual indicator to indicate when the touch screen is in a condition where a single touch is needed to initiate operation of the blender (after Step 1);

c) A time-out function on the first step of no longer than 30 seconds; and

d) Instructions as specified 65.5.

30.4 With respect to 30.3, after the operation of the blender is manually stopped, or after automatically stopping at the completion of a programmed sequence, the blender shall return to a condition requiring a two-step function to initiate operation.

30.5 With respect to 30.4, for a blender with a momentary contact pulse operation, Step 1 may remain active as long as the duration between the Pulse operations is no more than 30 seconds.

30.6 A capacitive touch screen control on a blender with a two-step ON function as specified in 30.3 shall additionally be subjected to the following without loss of the two-step ON function:

a) Evaluation in accordance with 28.7;

b) Electrostatic Discharge of in accordance with Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test, IEC 61000-4-2, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity are applied at each preselected point; and

c) Radiated Fields in accordance with Radiated, radio-frequency, electromagnetic field immunity test, Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test, IEC 61000-4-3, test level 3 being applicable.

30.7 If a blender has a capacitive touch screen, which is part of the enclosure of live parts, the material shall be capable of withstanding the stresses likely to be encountered in actual service. Such parts shall be subjected to the Ball Impact Test in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. After the impact test, the blender shall then be subjected to the Overflow Test of 41.1 unless the blender is no longer functional or the surface withstands the impact test without cracking or breaking.

31 Wand-type Mixers (Immersion Blenders)

31.1 A hand-held wand-type mixer shall be provided with a momentary contact ON/OFF switch (defined in 3.20) having the following features:

a) The switch shall be recessed or guarded as required in 31.6; and

Exception to (a): A hand-held wand-type mixer requiring two separate actuations to energize the unit. The last actuation shall be a momentary contact ON/OFF switch.

b) A single motion shall be required to de-energize the unit; and

c) The switch shall not be capable of locking in a continuous ON mode.

Exception to (c): A hand-held wand-type mixer may be provided with a continuous ON mode under the following conditions:

a) It is provided with visual indicator so the operator can determine by visual inspection that the appliance is operating (e.g. the blade is rotating); and

b) The operation shall require at least two separate actuations to engage the continuous ON mode. The two actuations shall include:

1) A momentary contact ON/OFF switch must first be actuated to initiate operation of the unit; and

2) A separate actuation to engage the continuous ON mode. After the continuous ON mode is engaged, the momentary contact ON/OFF switch may be released; and

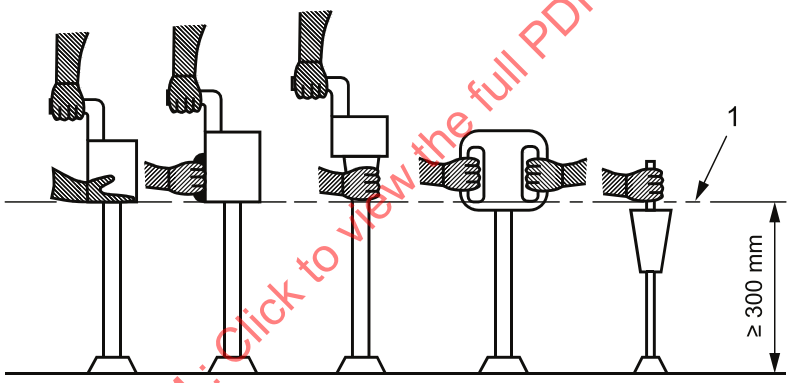
c) A single actuation shall de-energize the unit; and

d) The blade shall be guarded as required in 31.3; and

f) The grip zone and the grips shall be designed and constructed in such a way that the user's hands are kept away from the rotating attachment. The distance between the lowest grip point specified by the manufacturer and the rotating attachment shall not be less than 12 inches (300 mm), as shown in Figure 31.1.

Figure 31.1

Safety distance between the grip zone and the tool



Key

1 Lower limit of the grip zone

31.2 A non-hand-held wand-type mixer that is:

a) Intended to be mechanically attached to a mixing container, and

b) Provided with an interlock switch that must be actuated only by this mechanical attachment to the container before ON operation of the appliance can occur,

is not required to be provided with the momentary contact ON/OFF switch specified in 31.1. The interlock system shall comply with the interlock system requirements of 6.19.3. The mixing container may be provided with the appliance, or recommended by the manufacturer in the instructions.

31.3 A wand-type mixer is considered to comply with 23.1 if it is provided with top and side blade guarding that affords the necessary protection for the blade against contact with sides/bottom of bowl surfaces, and the user against inadvertent blade contact. Any openings in the top and side blade guarding shall not permit the entrance of the flat end of a 3/8 inch (9.5 mm) diameter rod, when placed perpendicular to the guard. As an alternate means of evaluation, any openings in the guarding shall not

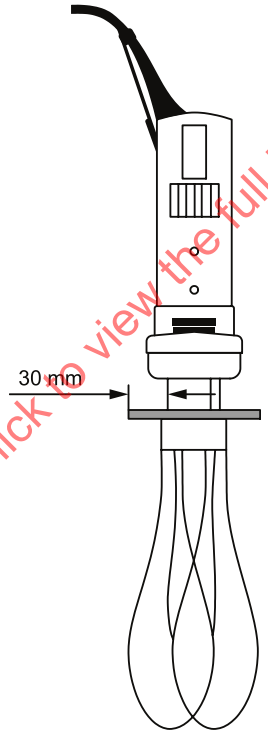
permit contact of the flat end of a 5/16 inch (8 mm) diameter rod of unlimited length with the blades, when placed at an angle of 45 degrees to the drive shaft. The bottom circular opening shall not be guarded in a manner that would interfere with the intended operation of the appliance.

31.4 If the blades are removable, the slicing/cutting assemblies provided with wand-type mixers shall be provided with a means to minimize the risk of a cut-type injury (such as stems, finger holes, grips handles and the like) during insertion and removal.

31.5 For wand-type mixer provided with a whisk or mixer attachment, a guard shall be provided to avoid accidental slipping of the hand into the rotating parts. The dimension of the guard shall be at least 1.2 inches (30 mm) greater than the dimensions of the grip zone specified by the manufacturer in all direction, and it shall be located between the grip zone and the rotating attachment as shown in Figure 31.2.

Figure 31.2

Minimum dimension of protecting guard flange



31.6 The switch is considered to be recessed or guarded to reduce the risk of unintentional operation if a cylindrical rod, having a diameter of 1.58 inches (40 mm) and a hemispherical end, applied with a force not exceeding 1.1 lbf (5 N) perpendicular to the switch actuator, does not operate the unit.

NOTE: Based on the design of the product, if necessary, the appliance can be dis-assembled to conduct this test.

32 Stability

32.1 A machine shall not overturn when tested as described in the Stability Test, Section 52.

Exception No. 1: A machine that is completely hand supported in normal use need not be tested.

Exception No. 2: A machine that is intended to be mounted to a supporting surface such as the floor, wall, or ceiling need not be tested.

PERFORMANCE

33 General

33.1 Representative samples of the machine shall be subjected to the applicable tests described in Sections 34 – 58. Each test shall be conducted at the input voltage indicated in Table 33.1 unless otherwise specified.

Table 33.1
Test voltages

Rated voltage (V)	Test voltage (V)
110 – 120	120
200 – 208	208
220 – 240	240
265 – 277	277
440 – 480	480
555 – 600	600

33.2 In tests on a machine, the maximum normal load is considered to be that load which 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 that are recommended by the manufacturer of the machine. Test loads that have been found to be close approximations of the most severe conditions of normal use are described in 36.2.1 – 36.20.5 for some common machine. However, machines having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements.

33.3 Where a test requires a food load, the machine is to be loaded to the maximum amount possible unless specifications are provided with the machine. Unless otherwise indicated, the foods used are to be those recommended by the manufacturer.

33.4 A machine having a single frequency rating is to be tested at that frequency. A machine rated ac/dc or dc-60 Hz is to be tested on direct current or 60-Hz alternating current, whichever results in higher temperatures. A machine rated 25 – 60 Hz or 50 – 60 Hz is to be tested on 60-Hz alternating current.

34 Starting Current Test

34.1 A machine shall start and operate normally on a circuit protected by a non time-delay fuse having a current rating corresponding to that of the branch circuit to which the machine should be connected. The performance is unacceptable if the fuse opens or an overload protector provided as part of the machine trips.

Exception: The requirement concerning a non time-delay fuse does not apply if:

a) The construction of the machine, or the nature of its usage, is such that it is likely to be used continually on the same branch circuit after installation,

b) The machine will start and operate normally on a circuit protected by a time-delay fuse, and

c) The machine is marked in accordance with 63.1.7.

34.2 In a test to determine whether a machine complies with the requirement in 34.1, the machine is to be started three times, with the machine at room temperature at the beginning of the test. Each start of the motor 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 machine – and the motor is to be allowed to come to rest between successive starts.

35 Input Test

35.1 The current or wattage input to a machine shall not be more than 110 percent of the rated value when the machine is operated under the condition of maximum normal load as described in 33.2 and 36.2.1 – 36.22.1 as applicable, and when connected to a supply circuit of maximum rated voltage.

35.2 For a machine having a single voltage rating, such as 115 V, maximum rated voltage is considered to be that single value of voltage. If the rating is given in terms of a range of voltages, such as 110 – 120 V, maximum rated voltage is considered to be the highest value of the range.

36 Normal Temperature Test

36.1 General

36.1.1 A machine, shall be tested as described in 33.2 and 36.2.1 – 36.22.1 and shall not reach a temperature at any point high enough to cause a risk of fire, to damage any materials in the machine, or to exceed the temperature rises specified in Table 36.1. The vibration of normal operation shall not cause any adverse effects, such as loosening of any mechanical or electrical connections of the machine, as determined by physical inspection of the machine performed after the completion of this test.

36.1.2 A thermal- or overload-protective device shall not open the circuit during the temperature test.

36.1.3 All values of temperature rise in Table 36.1 are based on an assumed ambient temperature of 25°C (77°F). Tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

36.1.4 Coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting of these devices – for example, a coil immersed in sealing compound – or unless the coil wrap includes thermal insulation or more than two layers – 1/32 inch (0.8 mm) maximum – of materials, such as cotton, paper, or rayon. For a thermocouple-measured temperature of a coil of an alternating-current motor, other than a universal motor, having a diameter of 7 inches (178 mm) or less – items 7 and 9 in Table 36.1 – the thermocouple is to be mounted on the integrally applied insulation on the conductor.

Table 36.1
Maximum temperature rises

Materials and component parts		Degrees	
		C	F
1.	Capacitors:		
	Electrolytic [a]	40	72
	Other types [b]	65	117
2.	Fuses:		
	a) Class CC, G, J, or T	85	153

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and component parts	Degrees	
	C	F
b) Other than Class CC, G, J, and T[c]	65	117
3. Fiber employed as electrical insulation.	65	117
4. At any point within a terminal box or wiring compartment of a permanently connected machine in which power-supply conductors are to be connected, including such conductors themselves, unless the machine is marked in accordance with 63.2.1.	35	63
5. For a machine that is not likely to be moved often in service, a surface upon which the machine may be supported and surfaces that may be adjacent to the machine when so supported.	65	117
6. Class A insulation system on coil windings of an a-c motor having a diameter of more than 7 inches (178 mm), of a d-c motor, and of a universal motor[d,e]		
a) In an open motor:		
Thermocouple method	65	117
Resistance method	75	135
b) In a totally enclosed motor:		
Thermocouple method	70	126
Resistance method	80	144
7. Class A insulation systems on coil windings of an a-c motor having a diameter of 7 inches (178 mm) or less, not including a universal motor, and on a vibrator coil[d,e]		
a) In an open motor and on a vibrator coil:		
Thermocouple or resistance method	75	135
b) In a totally enclosed motor:		
Thermocouple or resistance method	80	144
8 Class B insulation systems on coil windings of an a-c motor having a frame diameter of more than 7 inches (178 mm), of a d-c motor, and of a universal motor[d,e]		
a) In an open motor:		
Thermocouple method	85	153
Resistance method	95	171
b) In a totally enclosed motor:		
Thermocouple method	90	162
Resistance method	100	180
9. Class B insulation system on coil windings or an a-c motor having a diameter of 7 inches (178 mm) or less, not including a universal motor[d,e]		
a) In an open motor:		
Thermocouple or resistance method	95	171
b) In a totally enclosed motor:		
Thermocouple or resistance method	100	180
10. Class 155 (F) insulation systems on coil windings on an a-c motor having a frame diameter of 7 in (178 mm) or less, not including a universal motor, and on a vibrator coil[a]		
a) In an open motor:		
Thermocouple or resistance method	120	216
b) In a totally enclosed motor:		
Thermocouple or resistance method	125	225
11. Class 155 (F) insulation on coil windings of a-c motors having a frame diameter of more than 7 in (178 mm), and of a d-c motor, and a universal motor[a]		

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and component parts	Degrees	
	C	F
a) In open motors:		
Thermocouple method	110	198
Resistance method	120	216
b) In totally enclosed motors:		
Thermocouple method	115	207
Resistance method	125	225
12. Class 180 (H) insulation on coil windings of a-c motors having a frame diameter of 7 in (178 mm) or less – not including a universal motor – and on a vibrator coil[a]		
a) In open motors:		
Thermocouple or resistance method	135	243
b) In totally enclosed motors:		
Thermocouple or resistance method	140	25
13. Class 180 (H) insulation on coil windings of a-c motors having a frame diameter of more than 7 in (178 mm), of a d-c motor, and a universal motor[a]		
a) In open motors:		
Thermocouple method	125	225
Resistance method	135	243
b) In totally enclosed motors:		
Thermocouple method	130	234
Resistance method	140	252
14. Class 105 insulation systems on windings of an electrical component, such as a relay or a solenoid[d]		
Thermocouple method	65	117
Resistance method	85	153
15. Class 130 insulation systems on windings of an electrical component, such as a relay or a solenoid[d]		
Thermocouple method	85	153
Resistance method	105	189
16. Class 130 insulation systems on vibrator coils:		
Thermocouple or resistance method	95	171
17. Phenolic composition employed as electrical insulation or as a part the deterioration of which would result in a risk of fire or electric shock[f]	125	225
18. Rubber- or the thermoplastic-insulated wire and cord[f,g,h]	35	63
19. Sealing compound	40°C (104°F) less than melting point	
20. Varnished-cloth insulation	60	108
21. Wood and other combustible material.	65	117
22. Transformers with Class 105 insulation system:		
Thermocouple method	65	117
Resistance method	75	135
23. a) Copper, tinned or bare strands		
1) Less than 0.015 inch (0.38 mm) diameter	125	225
2) 0.015 inch (0.38 mm) diameter and larger	175	315

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and component parts	Degrees	
	C	F
b) Nickel, gold, or silver platings or combinations of those platings, over copper conductors	225	405

[a] The temperature rise on insulating material integral with the enclosure of an electrolytic capacitor that is physically integral with or attached to a motor may be not more than 65°C (117°F).

[b] A capacitor that operates a temperature rise of more than 65°C (117°F) may be judged on the basis of its marked temperature limit.

[c] A fuse that has been investigated and found to be acceptable for use at a higher temperature may be used.

[d] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by a thermocouple may be higher by the following amount than the maximum indicated:

Item	Additional temperature rise, Degrees	
	C	F
Part A of item 6	15	27
Part A of item 7	5	9
Part A of item 8	20	36
Part A of item 9	10	18
14	15	27
15	15	27

provided that the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table.

[e] See footnote a of Table 17.1 .

[f] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and found acceptable for use at high temperatures.

[g] Rubber-insulated conductors within a Class-A-insulated motor, rubber-insulated motor leads, and a rubber-insulated flexible cord entering a motor may be subjected to a temperature rise of more than 35°C (63°F), if the conductor is provided with a braid that has been investigated and found acceptable for use at the higher temperature; and a rubber-insulated conductor of a flexible cord may be subjected to a higher temperature rise. However, this does not apply to themoplastic-insulated wires or cords.

[h] A short length of rubber- or thermoplastic-insulated flexible cord exposed to a temperature of more than 60°C (140°F), such as at terminals, is acceptable if supplementary heat-resistant insulation of adequate dielectric strength is employed on the individual conductors of the cord to protect the conductor insulation against deterioration.

36.1.5 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). 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. The thermocouple wire is to conform with the requirements for Special Tolerances thermocouples as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

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

36.1.7 For a machine that is obviously not intended for continuous operation, the intermittent or short-time operation of the machine is to be taken into consideration when conducting the temperature test.

36.1.8 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 not less than 5-minute intervals, indicate no change.

36.1.9 In accordance with 20.1, a machine incorporating an air filter at ventilation openings shall be tested under maximum normal load with a clean filter in place. The test shall be repeated with the air filter

blocked 50 percent. For the blocked condition, the 50 percent blockage is stated as a percentage of the total air flow of a new filter through the effective area of the filtered opening. The 50 percent air flow shall be maintained across the effective area of the filtered opening. The filter shall be of the type recommended by the manufacturer and installed in accordance with the instructions.

Exception: In accordance with 20.4 and 54.1, the test may be conducted with a clean filter and with the air filter completely (100%) blocked.

36.2 Meat saws and meat slicers

36.2.1 A meat saw or meat slicer is to be operated without a food load for the input and temperature tests. For the temperature test, the machine is to be operated continuously until temperatures stabilize.

36.3 Meat choppers and meat grinders

36.3.1 The input test is to be conducted grinding or chopping pieces of beef, such as boneless chuck. During the test, the meat is to be self-fed into the hopper without the application of external pressure to force it into the machine.

36.3.2 For the temperature test, the machine is to be operated continuously without a load, except that small pieces of meat are to be chopped or ground occasionally or lubricating oil applied during the test to lubricate the cutting teeth, until temperatures stabilize.

36.4 Meat tenderizers

36.4.1 The input test is to be conducted tenderizing 1/2 inch (13 mm) thick boneless steak. For the temperature test, the machine is to be operated continuously without a food load until temperatures stabilize.

36.5 Ice crushers

36.5.1 The input test is to be conducted processing ice cubes that are approximately 1 in^3 (25 mm^3) in size with the control adjusted to all settings. For the temperature test, the machine is to be operated continuously processing ice cubes at the setting that resulted in the highest input until temperatures stabilize; see 36.1.8.

36.5.2 Ice crushers integral with an ice dispenser are to be operated as specified in 36.6.

36.6 Ice dispensers

36.6.1 The input test is to be conducted dispensing ice with the hopper full. For the temperature test, the machine is to be operated dispensing ice;

a) Continuously until the hopper is empty; and

b) 5-seconds on, 15-seconds off until temperatures stabilize.

The hopper is to be refilled when emptied during the cycling operation. If the ice dispenser includes an ice crushing feature, testing shall be conducted with and without the ice crusher operating.

36.7 Liquid dispensers

36.7.1 The input test is to be conducted dispensing water in the intended manner. For the temperature test, the machine is to be operated cyclically, 5-seconds of dispensing water, followed by a 15-seconds off until temperatures stabilize.

36.8 Vegetable shredder-slicers

36.8.1 The input test is to be conducted shredding and slicing vegetables using the various attachments provided. The food is to be placed in the food chute and pressure is to be applied on the food pusher to maintain the cutting action without forcing the process.

36.8.2 For the temperature test, the machine is to be operated continuously without a food load until temperatures stabilize.

Exception: A machine that processes food at a rate of 2-1/2 pounds (1.1 kg) or less per minute, and is constructed with a feed and discharge opening, may be tested slicing 50 pounds (22.8 kg) of potatoes, followed by a 5-minute off period, and then followed by shredding 50 pounds (22.8 kg) of carrots.

36.9 Bread slicers

36.9.1 A bread slicer is to be operated without a food load, for the input and temperature tests. For the temperature test, the machine is to be operated continuously until temperatures stabilize.

36.10 Food mixers

36.10.1 The input test is to be conducted while the machine is mixing the bread dough load specified in Table 36.2. The speed and amount shall be in accordance with the instructions provided with the machine.

Table 36.2
Specification for bread dough

Ingredient	Percentage of dough weight
Flour	55.4
Water	33.2
Yeast	1.1
Salt	1.4
Sugar	2.8
Shortening	2.8
Dry skim milk	3.3

36.10.2 For the temperature test, the machine is to be operated continuously at 80 percent of the maximum average input obtained during the input test until temperatures stabilize.

36.10.3 As an alternate means of evaluation, a food mixer may be subjected to the input and temperature tests described in 36.10.4 and 36.10.5.

36.10.4 The input test is to be conducted while the machine is mixing the ingredients for the bread dough load as specified in Table 36.2. The speed of the machine and the amount of dough is to be in accordance with the instructions provided with the machine. The mixer is to be operated until the desired consistency

of the dough is reached. At that time, the total "on" time of the mixer and the input are to be recorded for use during the temperature test, described in 36.10.5.

36.10.5 The Normal Temperature Test is to be conducted with the mixer operating continuously through cycles of operation while loaded at the recorded input value until temperatures stabilize. Each “on” period is to be of the same length of time as recorded during the input test. The “off” period is to be as indicated in Table 36.3.

Table 36.3
“Off” time

Dough capacity (lbs)	“Off” time (min)	
	Without removable bowl/trolley	With removable bowl/trolley
0 – 150	6	2
151 – 200	9	3
201 – 300	12	5
> 300	15	7

36.11 Coffee grinders and coffee mills

36.11.1 The input test is to be conducted processing coffee beans in each grinding mode. For the temperature test, the machine is to be operated continuously grinding coffee beans in the mode that caused the highest input obtained during the input test until temperatures stabilize.

36.12 Food cutters and food slicers

36.12.1 A food cutter or food slicer is to be operated without a food load for the input and temperature tests. For the temperature test, the machine is to be operated continuously until temperatures stabilize.

36.13 Food mixers-grinders

36.13.1 The input test is to be conducted, first mixing and then grinding meat, such as boneless chuck. For the temperature test, the machine is to be operated continuously without a load, except that small pieces of meat are to be dropped in occasionally or lubricating oil applied during the test to lubricate the cutting piece, until temperatures stabilize.

36.14 Food processors

36.14.1 For a food processor having a capacity of 10 quarts (10.6 L) or less, the input test is to be conducted as follows:

a) Processing various foods, such as meats and hard cheese, in the quantities recommended in the instructions provided with the machine using the metal cutting-mixing blade (S-blade), and

b) Slicing or shredding the various foods recommended using the slicing or shredding discs. The food is to be placed in the food chute and pressure is to be applied on the food pusher to maintain the cutting action without forcing the process.

If the input current fluctuates, the maximum average value for each food processed is to be recorded.

36.14.2 The temperature test for the food processor described in 36.14.1 is to be conducted as follows:

a) The machine is to be operated in accordance with the test outlined in 36.8.2 if the machine is provided with an attachment for shredding or slicing, and then

b) At a duty cycle of 1 minute "on", 1 minute "off" with the metal cutting-mixing blade (S-blade) installed and loaded to cause the highest input measured during the input test. This cyclic operation is to continue until temperatures stabilize.

Exception: A food processor that has a bowl capacity of 2.5 quarts (2.37 L) or less is to be tested as above except the duration is to be two hours.

36.14.3 For a food processor having a capacity of more than 10 quarts (10.6 L) and not more than 60 quarts (63.4 L), the input test is to be conducted processing the bread dough specified in Table 36.2. The temperature test is to be conducted making bread dough from the ingredients specified in Table 36.2 for 15 cycles, with a 4 minute "off" period between cycles. The speed and amount of dough processed shall be in accordance with instructions provided with the machine. The maximum temperatures attained are to be recorded.

36.15 Potato peelers

36.15.1 The input test is to be conducted peeling potatoes. For the temperature test, the machine is to be operated peeling ten hoppers of potatoes. If necessary for reloading the hopper, the machine is to be stopped and restarted after each full hopper of potatoes has been peeled; otherwise the operation is to be continuous. For a machine provided with a timer switch, the switch is to be reset while the hopper of potatoes is being peeled if a single maximum on period of the switch does not result in a thorough peeling operation. The same potatoes may be used throughout the test; in which case the time for completing the peeling of the first hopper of potatoes is to be noted and the same time interval used for each of the remaining loads.

36.16 Churns

36.16.1 The input and temperature tests are to be conducted making butter using a mixture of eight parts of heavy cream to one part buttermilk. The mixture is to be kept at a temperature of 18°C (64°F) for several hours prior to the tests. For the tests, a churn is to be loaded to the capacity that it will accommodate without spillage while operating. The churn is to be operated until butter is produced. Operation is to be discontinued 3 minutes after the first evidence of butter formation appears.

36.17 Dough rollers, molders, and dividers

36.17.1 The machine is to be operated processing dough as intended for the input and temperature tests. For the temperature test, the machine is to be operated continuously until temperatures stabilize.

36.18 Liquid mixers – spindle type

36.18.1 The input test is to be conducted using a water load. For the temperature test, a liquid mixer is to be operated for 10 complete cycles, each cycle consisting of 3 minutes of operation with the maximum capacity water load, followed by a 1-minute idling period. During the idling period, the liquid container is completely removed from the driving mechanism. If adverse operation or abuse to the rotating drive coupling could occur during removal or replacement of the liquid container, the 1-minute period between water loads is to be with the drive coupling not rotating but with the motor running or the unit is to be deenergized if necessary to stop the rotation of the drive coupling. A liquid mixer so tested shall have operating instructions provided that describe this method of usage, that is, that the driver is to be stopped when removing or replacing the liquid container.

36.18.2 Except as indicated in 36.18.3, the liquid-mixer capacity mentioned in 36.18.1 is to be the amount of water which completely fills the container with the unit operating at the highest speed setting. A container cover is to be removed when the capacity is determined.

36.18.3 If the amount of water placed in the container for determining the capacity of the liquid-mixer is less than either:

a) The marked capacity of the container; or

b) The maximum amount recommended in the instructional material packaged with the mixer,

the amount of water placed in the container is to be the greater of these two amounts. The cover, if provided, is then to be left in place.

36.19 Vegetable trimmers

36.19.1 The input test is to be conducted trimming vegetables. For the temperature test, the machine is to be operated continuously without a food load until temperatures stabilize.

36.20 Blending mixers

36.20.1 A blending mixer of the type intended to reduce the combination of solid vegetables, or fruits, and a liquid to a blend of the two (a blender, emulsifier, or liquidizer) is to be tested for input and temperature as follows: The machine is to be subjected to 10 cycles of operation, with each cycle consisting of 3 minutes of operation followed by a 1-minute off period. For each cycle, a single-speed mixer is to be loaded to capacity with a mixture of soaked diced carrots and water. A multispeed mixer is to be tested at its highest and lowest speed in the manner just described, except that the load for the test at the lowest speed is to consist of water alone. The capacity of the mixer is to be determined in accordance with 36.20.4.

36.20.2 The input measurement is to be recorded 30 seconds after the first load cycle begins. If the machine stalls at the beginning of any cycle, the obstruction is to be removed and the test continued. If it stalls while running, the obstruction is to be removed and the entire test restarted after the machine has cooled to room temperature. If the machine stalls more than twice while running, the results of the test are not acceptable.

36.20.3 Paragraphs 36.20.1 and 36.20.2 do not apply to a machine intended for operation without liquid – such a machine is to be given separate consideration, with the load and duty cycle selected in such a manner as to take into account the intended use.

36.20.4 Except as indicated in 36.20.5, the blending mixer capacity is to be determined by loading the mixer with a mixture of soaked diced carrots and water in the ratio of 2 to 3 by weight, with approximately half of the weight of carrots consisting of pieces having a maximum dimension of less than 1/2 inch (12.7 mm) and the remainder consisting of pieces having a maximum dimension between 1/2 and 3/4 inch (12.7 and 19.1 mm). The carrot pieces are to be soaked in water for 24 hours and drained before being weighed and added to the mixture. The blending mixer is to be turned on to its highest speed, with the two-piece cover in place. More test mixture is to be added until no more mixture can be added without spillover or leakage, without the two-piece cover in place.

36.20.5 If the amount of mixture placed in the container for determining the capacity of the blending mixer, as determined by the method described in 36.20.4 is less than either:

a) The marked capacity of the container, or

b) The maximum amount recommended in the instructional material packaged with the mixer,

the amount of mixture placed in the container is to be the greater of these two amounts. The cover, if provided, is then to be left in place.

36.21 Can openers

36.21.1 The input test on a can opener is to be conducted using a No. 10 steel can having a 6-inch (152.4 mm) cover diameter. The temperature test is to be conducted opening twelve No. 10 size steel cans in succession with an off time of 5 seconds maximum between the opening of each can. During this interval, the opened can and cover are to be removed from the mechanism and an unopened can is to be inserted into the mechanism.

36.22 Wand-type mixers

36.22.1 A wand-type mixer is operated at high speed for 5 cycles consisting of 3 minutes on and 1 minute off. The carrot/water mixture described in 36.20.4 is to be added into a flat bottomed cylindrical bowl having a diameter of 4 inches (100 mm). The bowl shall be filled to 3/4 of the height of the shaft portion of the wand-type mixer or to the maximum immersion level, if marked. The mixture shall be changed and replaced with a fresh mixture after each of the five cycles.

Exception: If the loading recommended in the instruction manual may be more severe, additional input and temperature tests utilizing the loading outlined in the instruction manual shall be conducted.

36.23 Centrifugal juicers

36.23.1 The input to a centrifugal juicer shall be measured extracting the juice from the foods recommended by the manufacturer, such as carrots, celery and spinach.

36.23.2 For the temperature test, a centrifugal juicer for fruits and vegetables shall be operated juicing the food load resulting in the highest inputs until temperatures stabilize. If, during the operation of the unit, the juicer becomes so clogged that it begins to vibrate excessively, the appliance shall be turned off and cleaned. Then it shall be turned on and the juicing operation shall be continued until temperatures stabilize.

36.23.3 With the agreement of all concerned, a centrifugal juicer shall be operated with no load until temperatures stabilize and then begin the extraction operation outlined in 36.23.2.

36.24 Reamer (citrus) juicers

36.24.1 The input to a reamer juicer shall be measured extracting juice from oranges which have been cut approximately in half.

36.24.2 For the temperature test, a reamer juicer shall be operated for 1/4 minute of the actual extraction operation or its equivalent, followed by a 1/4 minute idling period, with the motor on but without added load on the reamer, until temperatures stabilize. A reamer juicer with a momentary-contact switch shall be deenergized between extractions.

36.24.3 With the agreement of all concerned, a reamer juicer shall be operated with no load until temperatures stabilize and then begin the extraction operation outlined in 36.24.2.

37 Dielectric Voltage-Withstand Test

37.1 A machine shall withstand for 1 minute without breakdown the application of a DC potential or an AC 60-Hz essentially sinusoidal potential applied between live parts and dead metal parts and any points

of the primary and secondary circuits with the machine in a well heated condition. Except as noted in 37.2 and 37.3, the test potential shall be:

a) 1000 V AC or 1400 V DC for a machine employing a motor rated 1/2 hp (373 W) or less and 250 V or less.

b) 1000 V AC plus twice the rated voltage or 1400 V DC plus 2.8 times rated voltage for a machine employing a motor rated more than 1/2 hp or more than 250 V.

37.2 The test potential for the secondary circuit of a machine employing a transformer or autotransformer shall be:

a) 1000 V AC plus twice the operating voltage or 1400 V DC plus 2.8 times rated voltage if the secondary operates at 251 – 600 V.

b) 1000 V AC or 1400 V DC if the secondary operates at 51 – 250 V.

c) 500 V AC or 700 V DC if the secondary operates at 50 V or less.

Exception: This does not apply if the secondary circuit is supplied from a Class 2 transformer.

37.3 A capacitor used for radio-interference elimination or arc suppression shall withstand for 1 minute without breakdown the application of a DC potential or an AC 60-Hz essentially sinusoidal potential between live parts of opposite polarity with the machine at the maximum operating temperature reached in normal use. The test potential shall be:

a) 1000 V AC or 1400 V DC for a machine employing a motor rated 1/2 hp (373 W) or less and 250 V or less.

b) 1000 V AC plus twice the rated voltage or 1400 V DC plus 2.8 times rated voltage for a machine employing a motor rated more than 1/2 hp or more than 250 V.

37.4 To determine whether a machine complies with the requirements in 37.1 – 37.3, the machine is to be tested by means of a 500 VA or larger transformer, having a DC output voltage or an AC output voltage that is essentially sinusoidal and that can be varied. The applied potential is to be increased from zero until the required test value is reached and is to be held at that value for 1 minute. The increase in the applied potential is to be at a substantially uniform rate and as rapid as consistent with its value being correctly indicated by a voltmeter.

38 Leakage Current Test

38.1 When tested in accordance with 38.3 – 38.8, the leakage current of a cord- and plug-connected ice dispenser or counter-top, portable machine weighing 40 lbs or less, rated for a nominal 120- or 240-volt single-phase supply shall not exceed 0.5 mA.

Exception No. 1: A three-wire (including grounding conductor) cord-and-plug-connected ice dispenser that is intended to be fastened in place or located in a dedicated space, shall have a leakage current no greater than 0.75 mA.

Exception No. 2: Those conductive parts of a stationary ice dispenser that comply with all of the specifications in (a) – (d) below shall have a leakage current from simultaneously accessible parts to the grounded supply conductor no greater than 3.5 mA. The leakage current between simultaneously accessible parts shall not exceed 0.5 mA.

a) The product is provided with electromagnetic interference (EMI) suppression filtering;

b) The product is equipped with a grounding-type supply cord and plug;

c) The product is not intended for outdoor installation; and

d) It is considered unlikely that high leakage conductive parts will be contacted during normal use.

1) The front of an ice dispenser is considered likely to be contacted in normal use.

2) The recessed area where ice is dispensed (backsplash surround) is considered an area unlikely to be contacted during normal use.

3) The sides of an ice dispenser are considered likely to be contacted in normal use, unless installation instructions are provided for installing in a manner that the sides are protected from unintentional contact, such as in a recessed area.

4) The cover of a manually-filled ice hopper is considered likely to be contacted in normal use when refilling the ice hopper.

38.2 Leakage current refers to all current, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of the machine and ground or other exposed surfaces of the machine.

38.3 All exposed conductive surfaces are to be tested for leakage currents. Leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively if simultaneously accessible, and from one surface to another if simultaneously accessible. A part is considered to be exposed unless it is guarded by an enclosure that protects against the risk of electric shock. Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to involve a risk of electric shock. If all accessible surfaces are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current can be measured between the grounding conductor and the grounded supply conductor. If exposed dead metal parts of the machine are connected to the neutral supply conductor, this connection is to be open during the test.

38.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 10 by 20 cm (3.9 by 7.9 inches) in contact with the surface. If the surface is less than 10 by 20 cm, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the machine.

38.5 The measurement circuit for leakage current is to be as shown in Figure 38.1. The measurement instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument; it need not have all the attributes of the defined instrument.

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 µf.

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

c) Over a frequency range of 0 – 100 KHz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 µf capacitor to 1500 ohms. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

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

38.7 A representative machine is to be tested for leakage current in the as-received condition. The machine is considered to be in the as-received condition if it is without prior energization except as may occur as part of the production-line testing. The grounding conductor, if any, is to be open at the attachment plug. The supply voltage is to be in accordance with Table 33.1. The test sequence, with reference to the measuring circuit, Figure 38.1, is to be as follows:

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

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

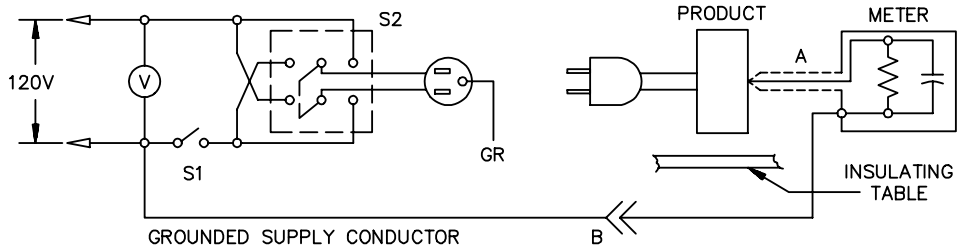
c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is considered to be obtained by operation as in the normal temperature test.

38.8 The complete leakage-current-test program as described in 38.7, is to be conducted without interruption for other tests. However, with the concurrence of those concerned, the leakage current test may be interrupted for the purpose of conducting other nondestructive tests.

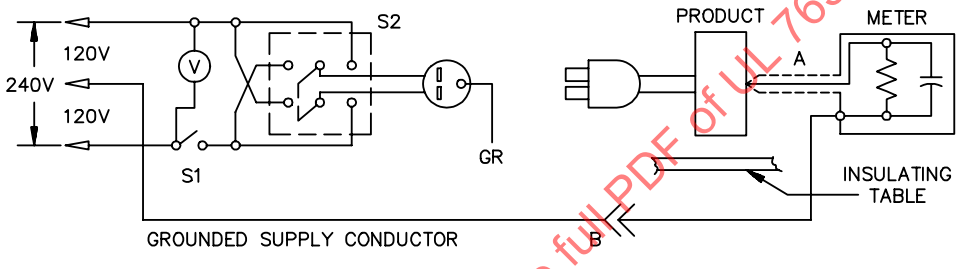
Figure 38.1

Leakage-current measurement circuits

a) Machine intended for connection to a 120–V power supply.



b) Machine intended for connection to a 3–wire, grounded–neutral power supply.



Notes:

A – Probe with shielded lead.

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

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39 Leakage Current Following Humidity Conditioning Test

39.1 A cord- or plug-connected ice dispenser or counter-top, portable machine weighing 40 lbs or less, rated for a nominal 120- or 240-volt single-phase supply shall comply with the Leakage Current Test, Section 38, following exposure for 48 hours to air having a relative humidity of 88 ±2 percent at a room temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

39.2 To determine compliance with 39.1, a representative machine is to be heated to a temperature just above 34°C (93°F) to reduce the likelihood of condensation of moisture during conditioning. The heated machine is to be placed in the humidity chamber and is to remain for 48 hours under the conditions specified in 39.1. Following the conditioning, the machine is to be tested unenergized as described in 38.7(a). The machine is then to be energized and tested as described in 38.7 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases.

40 Overspeed Test

40.1 To determine whether a machine employing a series motor complies with the requirement in 25.2, it is to be tested as described in 40.2. Parts that can become a risk of injury to persons shall not work loose as a result of the test.

40.2 A machine employing a series motor is to be operated for 1 minute at the no-load speed resulting from application of 1.3 times rated voltage.

41 Flooding of Live Parts Tests

41.1 There shall not be any overflow of liquids into the motor of a counter-top machine that is provided with an open-top type container into which liquid is intended to be added by the user when the machine is tested as follows. One representative counter-top machine provided with an open-top type container into which liquid is intended to be added by the user is to be tested. The machine is to be positioned as intended for normal use: cover on but fill-hole open. The liquid container of the machine is to be completely filled with a salt-water solution (1/2 gram of NaCl per liter of distilled water). An additional quantity equal to 15 percent of the capacity of the container is to be poured in steadily over a period of 1 minute. If the machine is so designed that a liquid container is situated over the motor, the spillage test is to be conducted with the machine either switched off or in operation, whichever imposes the more severe condition. If the liquid container is not situated over the motor, the machine is to be operated for 5 minutes at the maximum speed setting, with the container kept continuously filled with the test solution to a level such that the greatest amount of splashing occurs. Following this conditioning, the machine is to be subjected to the Leakage Current Test, Section 38, and the Dielectric Voltage-Withstand Test, Section 37.

41.2 A counter-top machine employing bottom vents shall not draw liquid into the motor of the machine when tested as follows. One representative counter-top machine employing bottom vents is to be tested. The machine is to be placed in a smooth bottomed shallow pan having at least twice the length and width of the bottom of the machine being tested. The pan is to be filled to a depth of 1/16 inch (1.6 mm) with a salt-water solution (1/2 gram of NaCl per liter of distilled water), and the machine is to be operated at maximum speed for 1 minute. Following this conditioning, the machine is to be subjected to the Leakage Current Test, Section 38, and the Dielectric Voltage-Withstand Test, Section 37.

Exception: A counter-top machine which employs bottom vents and legs which space the vents more than 2 inches (50.8 mm) above the counter top need not be tested.

41.3 The deterioration of the liquid container's bottom seals or the motor shaft seal in a counter-top machine provided with an open-top type container into which liquid is intended to be added by the user shall not result in the entrance of liquid into the electrical or motor enclosure of the machine as determined below. One representative counter-top machine provided with an open-top type container into which liquid

is intended to be added by the user is to be tested. The liquid container's bottom seals and the motor shaft seal of the machine are to be removed one at a time. The liquid container is then to be completely filled with a salt-water solution (1/2 gram of NaCl per liter of distilled water) while on the base of the machine as in normal use. The test is to be conducted with the machine either switched off or in operation, whichever imposes the more severe condition. Following this conditioning, the machine is to be subjected to the Leakage Current Test, Section 38, and the Dielectric Voltage-Withstand Test, Section 37.

42 Wand-type Mixer Moisture Resistance Test

42.1 After exposure as described in 42.2, a wand-type mixer shall comply with the requirement in 38.1 in a repeat leakage current test, except that the test shall be discontinued when the leakage current stabilizes.

42.2 A wand-type mixer is to be connected to a supply circuit as described in 39.1 and the shaft is to be immersed in a salt water solution (1/2 gram of sodium chloride per liter of distilled water) and then tilted upward appropriately 105 degrees to allow the water to run down the shaft toward the enclosure. Twenty-five such operations are to be conducted at the rate of 10 operations per minute. This test is to be repeated on a second sample with the wand-type mixer not operating.

43 Blender Cover Opening Splash Test

43.1 To determine compliance with 29.4 Exception No. 1(b) for a blender provided with an opening that is not located in the center of the cover, the blender is to be tested in accordance with 43.2 and 43.3 in order to determine the ability of the blender cover to keep the contents of the blender container from splashing out.

43.2 The container of a representative blender is to be filled to the maximum fill line (or maximum recommended level) with hot tap water at a temperature not exceeding 93.3 ±5.5°C (200 ±10°F). The exterior of the blender is to be wiped dry. The blender container is to be mounted on the blender and the blender is to be placed on a horizontal work surface that is dry. The cover opening intended for pouring is then to be opened and the blender operated for 15 seconds at the highest speed setting available. This operation is to be repeated two more times.

43.3 No water shall be observed splashing out of the cover opening. The work surface and blender exterior shall remain dry.

44 Test for Deterioration of Parts Subject to Flexing

44.1 The deterioration of a part made of rubber, plastic, or a similar material, which is subject to flexing shall not result in a risk of electric shock as determined by 44.2.

Exception: 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 as far as these requirements are concerned.

44.2 To determine whether a machine complies with 44.1, the part subject to flexing is to be completely removed to simulate its deterioration and the machine operated through one complete cycle of normal operation. The machine is then to be tested as follows:

a) A cord-connected machine shall comply with the Leakage Current Test, Section 38, and the Dielectric Voltage-Withstand Test, Section 37.

b) A permanently-connected machine shall comply with the Insulation Resistance Test, Section 46, and the Dielectric Voltage-Withstand Test, Section 37.

45 Test for Parts Not Subject to Flexing

45.1 After the conditioning described in 45.2, a polymeric or elastomeric material used for a gasket, diaphragm, seal, or the like, or a rubber part subject to hot soapy water during cleaning shall have a tensile strength of not less than 75 percent and elongation of not less than 60 percent of the values determined before conditioning. At the conclusion of the tests, there shall not be visible deterioration, deformation, melting, or cracking of the material and the material shall not harden as determined by normal hand flexing.

Exception No. 1: A material that has been investigated in accordance with 45.4 may have physical properties other than those specified.

Exception No. 2: A noncomposite material that has been found to comply with the requirements in the Standard for Gaskets and Seals, UL 157, and that complies with the minimum acceptable elongation and tensile strength after aging is considered in compliance with these requirements.

45.2 A total of 20 pieces of each representative material is needed for this test. Five pieces are to be tested for elongation in the as-received condition and 5 pieces are to be tested for tensile strength in the as-received condition. The 10 remaining pieces are to placed in a circulating-air oven at a temperature of 69 – 70°C (156 – 158°F) for 168 hours. Five of the conditioned pieces are to be tested for elongation and the other 5 pieces are to be tested for tensile strength. The test methods and apparatus are described in the Standard for Test Methods for Rubber Properties in Tension, ASTM D 412-97.

45.3 A gasket of material other than mentioned in 45.1, such as bonded cork or impregnated fiber, that is not known to be reliable, shall be investigated for equivalent resistance to aging and temperature. Absorptive materials, such as cork or fiber shall not be used where they may contact a live part.

45.4 To determine acceptability of a material in accordance with Exception No. 1 to 45.1, a gasket, a diaphragm, or a seal of a counter-top machine is to be conditioned as specified in 45.2. Instead of the tensile and elongation testing, the gasket, diaphragm, or seal is then to be installed in the associated counter-top machine and subjected to the Flooding of Live Parts Tests, Section 41. The entire machine may be subjected to the accelerated-aging conditionings. When an entire machine is subjected to the accelerated-aging test, the gasket, diaphragm, or seal temperature shall be monitored and maintained at the value indicated in 45.2.

46 Insulation Resistance Test

46.1 Following the Test for Deterioration of Parts Subject to Flexing, Section 44, a permanently-connected machine 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 machine being tested. Designating the reading of the line voltage as V_1, the reading of the other voltmeter as V_2, and the resistance of V_2 as R, the insulation resistance is to be calculated by the formula:

$$Insulation\ \ Resistance = \frac{(V_1 - V_2)\,R}{V_2}$$

47 Hydrostatic Pressure Test

47.1 If a test is necessary to determine whether a part complies with requirements in 26.3 and 26.4, two samples of the part are to be subjected to a hydrostatic pressure test. Each sample is to be filled with water so as to exclude air, and is to be connected to a hydraulic pump. The pressure is to be raised gradually to 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 leakage at a gasket is acceptable if tests conducted with the media they are intended to contain show no indication of presenting a risk of injury to persons or a risk of electric shock.

48 Switch Overload Test

48.1 A switch or other device that controls a motor of a machine or that controls an electrical component, such as a solenoid or a relay coil shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation as described in 48.2 – 48.4 as applicable. There shall not be electrical or mechanical malfunction or breakdown of the device or undue burning or pitting of the contacts, and the fuse in the grounding connection shall not open.

Exception No. 1: A device known to be acceptable for the application need not comply with this requirement.

Exception No. 2: A device interlocked so that it will never break the locked-rotor motor current need not comply with this requirement.

48.2 In a test to determine whether the switch or other control device complies with the requirement in 48.1, exposed dead metal parts of the machine are to be connected to ground through a 3 A fuse, and the machine is to be connected to a grounded supply circuit. During the test the device is to be operated at a rate of not more than 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to those concerned.

48.3 The connection of the switch, or other control device is to be such that any single-pole, current-interrupting device will be located in the ungrounded conductor of the supply circuit. If the machine is intended for use on direct current, or on direct current as well as alternating current, the exposed dead metal parts of the machine are to be connected so as to be positive with respect to a single-pole, current-interrupting control device.

48.4 When testing a switch or other control device that controls an electrical component, such as a solenoid or a relay coil, the machine is to be connected to a supply circuit of 110 percent of the maximum rated voltage or the test voltage specified in Table 33.1, whichever is higher. The load on the device being tested is to be the same as that which it is intended to control in normal service.

48.5 When testing a switch or other control device that controls a motor, the rotor of the motor is to be locked in position and the machine is to be connected to a supply circuit of maximum rated voltage or the test voltage specified in Table 33.1, whichever is higher. See 33.4.

49 Interlock System Endurance Test

49.1 An interlock system which has not been shown to have been investigated for the purpose shall be subjected to the endurance test described in 49.2 and 49.3. As a result of the test:

a) There shall not be any electrical or mechanical malfunction of the interlock system or undue pitting or burning of the switch contacts, and

b) The fuse in the grounding connection shall not open.

49.2 To determine if an interlock system complies with the requirements in 49.1, the machine is to be connected to a grounded power-supply circuit of rated frequency and voltage. During the test, exposed dead metal parts of the machine are to be connected to ground through a 3 A non-time-delay plug fuse and the connection is to be such that any single-pole current interrupting device is in an ungrounded conductor of the supply circuit. If the machine is intended for use on direct current, exposed dead metal parts of the machine are to be so connected as to be positive with respect to a single-pole, current interrupting device.

49.3 The switch is to be operated at a maximum rate of 6 cycles per minute. The first 75,000 cycles are to consist of a minimum 1 second "on" and a maximum 9 seconds "off." For the last 25,000 cycles, the test is to be conducted with a 50 ±20 percent "on" time.

50 Wiring Flexing Test

50.1 In accordance with 15.1.9, if the normal operation, cleaning, user servicing or installation of an appliance causes movement of the internal wiring, the appliance shall be capable of operating in the intended manner for the number of cycles specified in Table 50.1. There shall be no electrical or mechanical malfunction and, after the test, the appliance shall comply with the requirements in Section 37, Dielectric Voltage-Withstand Test.

Table 50.1
Wiring Flexing Cycles

Flexing Condition	Number of Cycles
Normal Operation	30,000
Cleaning or User Servicing	6,000
Installation	50

50.2 In order to determine if there is any electrical or mechanical malfunction, the appliance shall be operated after completing of the specified number of cycles. If the motion of the internal wiring occurs while the appliance is operating, the appliance shall be operated while causing the movement of the internal wiring. No intermittent operation or other signs of damage to the wiring shall be observed.

50.3 The appliance is to be energized during the test when the motion of the internal wiring occurs while energized. The electrical load applied to the internal wiring may be simulated to represent the current and power factor under maximum normal operating conditions.

50.4 The cycling rate shall be:

a) Representative of the maximum speed of the movable member of the appliance during normal operation where the movable member is controlled by the motor, or

b) 12 cycles per minute where the movable member is operated manually.

50.5 When requested by the manufacturer, testing with an increased cycling rate is considered representative of the cycling rate specified in 50.3(b).

50.6 The movable member is to be so operated that it will reach the maximum limits of travel in both directions, each cycle.

50.7 When movement of the internal wiring occurs during installation or inspection of electrical field-wiring connections, the test shall be conducted with the field-wiring leads, branch-circuit wiring, and the like, as would be encountered in intended use, in place. In addition to the compliance criteria specified in 50.1, the testing shall not result in damage to the electrical insulation of the internal wiring.

51 Strain Relief Test

51.1 The strain relief means provided on an attached flexible cord, when tested in accordance with 51.2, shall withstand for 1 minute without displacement a direct pull of 35 pounds (156 N) applied to the cord, with the connections within the machine disconnected.

51.2 A 35-pound (15.9-kg) weight is to be suspended on the cord and supported by the machine so that the strain-relief means will be stressed from any angle that the construction of the machine permits. After the tests, the cord shall not have been longitudinally displaced by more than 2 mm, and the conductors shall not have moved over a distance of more than 1 mm in the terminals, nor shall there be appreciable strain at the connection.

52 Stability Test

52.1 To determine compliance with 32.1, a machine shall be tested in accordance with 52.2 – 52.4.

52.2 The machine is not to be energized during the stability test. The test is to be conducted under conditions most likely to cause the machine to overturn. The following conditions are to be such as to result in the least stability:

a) The position of all doors, drawers, casters, and other movable or adjustable parts, including that of the supply cord resting on the surface supporting the machine;

b) Connection of or omission of any attachment made available by or recommended by the manufacturer;

c) Provision of or omission of any normal load if the machine is intended to contain a liquid or other mechanical load; and

d) Direction in which the machine is tipped or the supporting surface is inclined. See 52.3.

52.3 In conducting the stability test, the machine is to be:

a) Placed on a plane inclined at an angle of 10 degrees from the horizontal; or

b) Tipped through an angle of 10 degrees from an at rest position on a horizontal plane.

52.4 With reference to the requirement in 52.3(b), the angle of 10 degrees is to be measured between the surface or plane of the surface of the machine originally in contact with the horizontal supporting surface and the horizontal supporting surface.

53 Abnormal Operation Test

53.1 Short-circuiting either the rectifier or the capacitor of a combination consisting of a rectifier and an electrolytic capacitor shall not create a risk of electric shock, fire, or injury to persons.

54 Abnormal Filter Blockage Test

54.1 A machine incorporating an air filter over ventilation openings shall be tested as described in 54.2 – 54.5, and as a result of the testing, there shall be no:

a) Emission of flame or molten metal;

b) Glowing or flaming of the tissue paper covered supporting surface or the cheesecloth covering the machine;

c) Opening of the 3 A fuse between accessible metal parts and ground;

d) Dielectric breakdown;

e) Exposure of live parts; or

f) Exposure of a mechanical parts that could cause injury to persons.

Exception: The Abnormal Filter Blockage Test need not be conducted if the machine complies with the Normal Temperature Test with the filter completely (100%) blocked.

54.2 A machine shall be operated as described in 54.4 under each of the following conditions, in turn:

a) Blocked 75%; and

b) Blocked 100%.

54.3 Each blockage is stated as a percentage of the total effective area of the filtered opening and shall be representative of the most severe and likely condition based upon the ventilation design.

54.4 The machine shall be installed and operated as described in 36.1 – 36.21, as applicable. The machine shall be:

a) Connected to a supply circuit as described in 33.1;

b) Placed on a white tissue paper covered softwood surface;

c) Draped with a double layer of cheesecloth over the whole machine with the cloth within 1/8 inch (3.2 mm) of the openings (if any) in the enclosure; and

d) Grounded by means of a 3 A non-time-delay plug fuse connected between exposed metal parts and earth ground.

54.5 Following operation as specified in 54.4, the machine shall comply with Accessibility of Live Parts, Section 11, and Protection Against Injury to Persons, Sections 21, 22 and 23; and be subjected to the Dielectric Voltage-Withstand Test, Section 37.

55 Water Spray Test

55.1 After the water spray test described in 55.3 and 55.4, a machine intended for outdoor use or use in a protected location shall:

a) For a machine as specified in 38.1, comply with the requirements in 38.1 in a repeated leakage current test, except that the test is to be discontinued when leakage current stabilizes.

b) For a machine other than as specified in (a), have an insulation resistance not less than 50,000 ohms between live parts and interconnected dead metal.

c) Withstand without breakdown for 1 minute the dielectric voltage-withstand test described in 37.1 between live parts and interconnected dead metal parts.

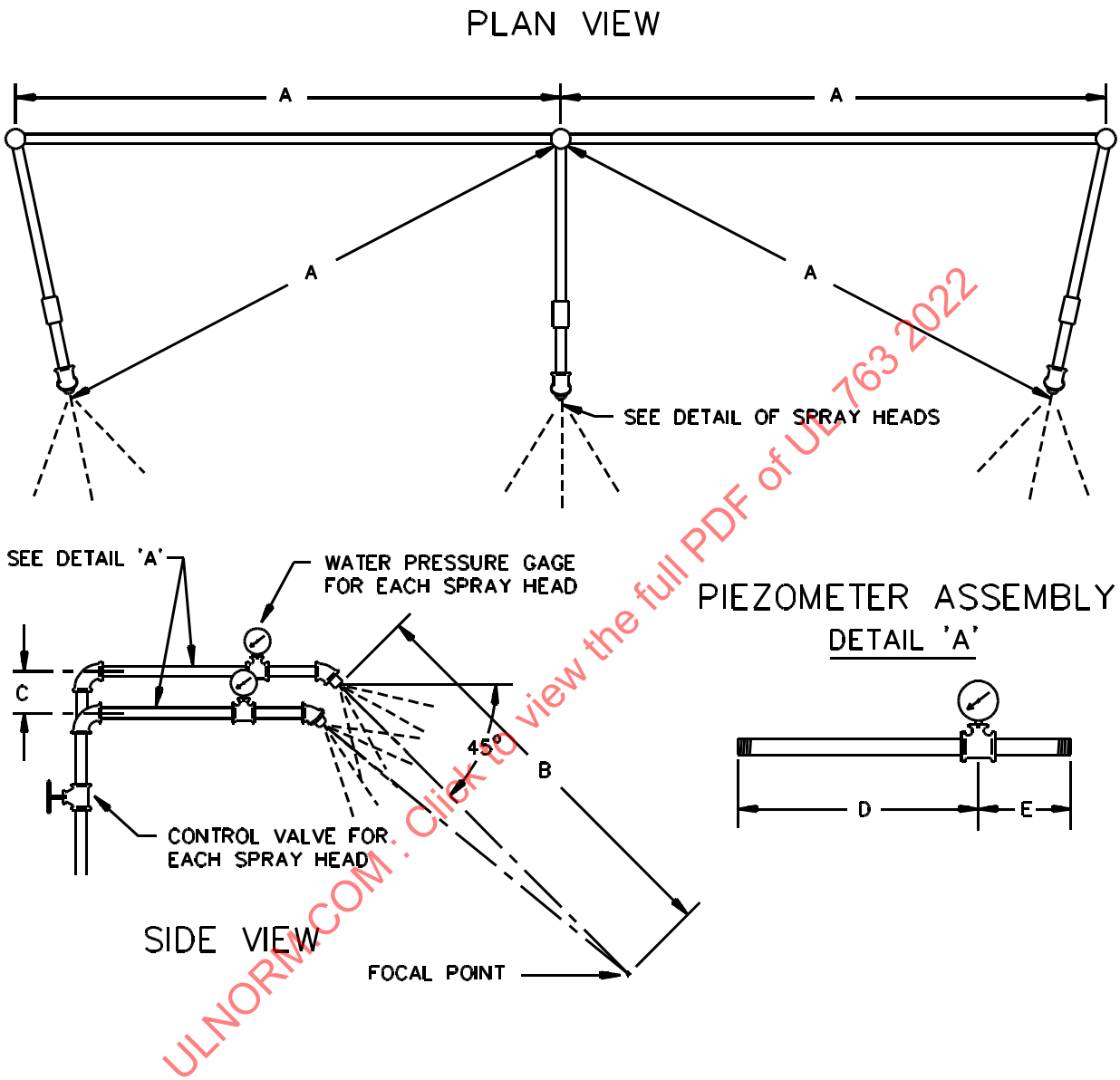
55.2 The test shall not result in the wetting of uninsulated live parts except that motor windings may be judged by the insulation-resistance and dielectric voltage-withstand tests provided the motors are constructed, located, or shielded so that the windings are not directly exposed to water during the test.

55.3 The machine is to be positioned and leveled in accordance with the manufacturer's instructions. A machine intended for use in a protected location is to be provided with a representative shelter, such as a roof, canopy, marquee, or similar structure, which is to be positioned over the machine, in accordance with the manufacturer's instructions. A machine intended for outdoor use is tested without a shelter. Following the water spray, the insulation resistance and leakage current are to be measured, and then the machine is to be tested for dielectric voltage-withstand in accordance with 37.1.

55.4 The water spray apparatus is to consist of three spray heads constructed in accordance with the details illustrated in Figure 55.1 and mounted in a water supply pipe rack as illustrated in Figure 55.2. The water pressure for all tests is to be maintained at 5 psi (34 kPa) at each spray head. The distance between the center nozzle and the machine is to be approximately 5 feet (1.5 m). The machine is to be brought into the focal area of the three spray heads in such a position and under such conditions as are most likely to result in entrance of water into the machine. The spray is to be directed at a 45-degree angle to the vertical toward the machine. The total exposure is to be for 1 hour.

Figure 55.1

Spray-head assembly

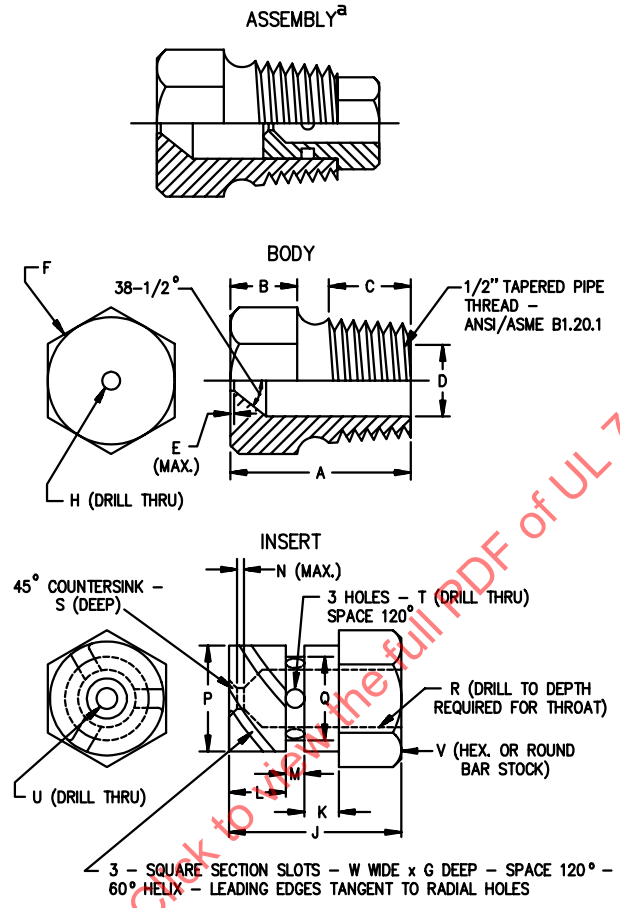


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101D

Figure 55.2

Spray-head pipe rack



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]	2.79
H	(No. 9)[b]	5.0	U	(No. 40)[b]	2.49
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] Molded nylon Rain-Test Spray Heads are available from Underwriters Laboratories, Inc.

[b] ANSI B94.11 Drill Size.

[c] Optional – To serve as wrench grip.

56 Adequacy of Mounting Test

56.1 A cord-connected machine intended for mounting on a wall shall be tested in accordance with 56.2 – 56.4. As a result of the test the mounting means shall not break, loosen, or pull out of the wall and the machine shall not separate from the mounting means. There shall not be any damage to the machine that would result in a risk of fire, electric shock, or exposure of a moving part capable of causing injury as determined by all of the following:

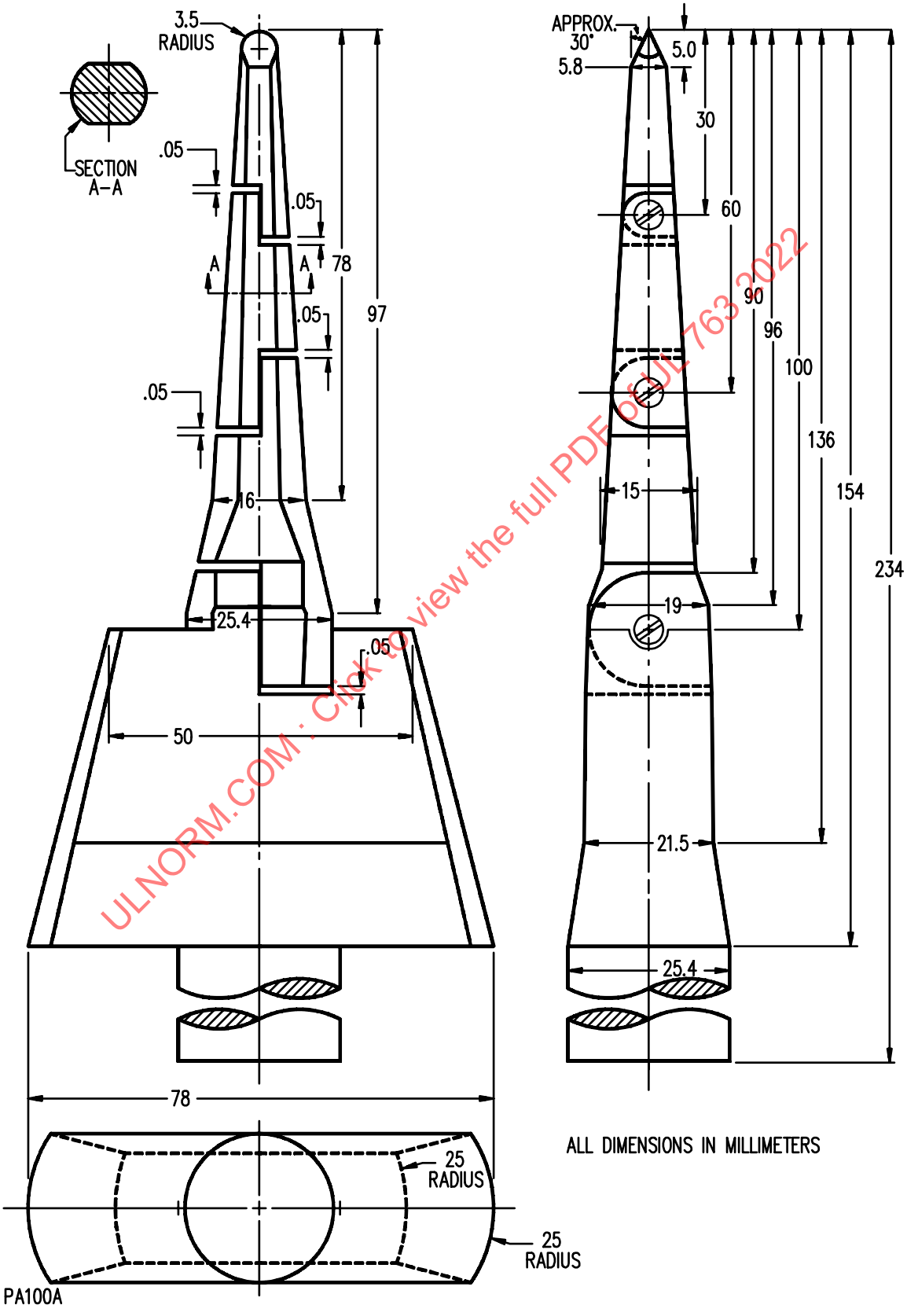
a) The insulation resistance between live and dead-metal parts shall not be less than 50,000 ohms;

b) The machine shall withstand for 1 minute without breakdown the application of a 60-Hz essentially sinusoidal potential of 1000 volts applied between live and dead-metal parts; and

c) Any cracking of the mounting means which occurs as a result of this test shall not result in exposure of moving parts capable of causing personal injury, as determined by use of the probe illustrated in Figure 56.1.

Figure 56.1

Accessibility probe



56.2 The test is to be conducted with the machine mounted in accordance with the manufacturer's installation instructions on any secure test wall. If the manufacturer describes more than one mounting configuration, the machine is to be mounted in the most severe mounting configuration. If the mounting configurations specified are significantly different, each configuration is to be tested separately. If the machine is not provided with installation instructions, it is to be mounted in the most severe mounting configuration.

56.3 A force is to be applied vertically through the center of gravity of the machine. The force is to be gradually increased to four times the combined weight of the machine and the maximum normal capacity, and then maintained for 1 minute.

56.4 If the mounting assembly is constructed of a thermoplastic material, the test shall be repeated on a machine subjected to the Mold Stress-Relief Distortion Test, Section 57.

57 Mold Stress-Relief Distortion Test

57.1 A machine with a mounting assembly constructed of a thermoplastic material shall be conditioned as described in 57.2.

57.2 One complete representative machine, or the part under consideration, is to be placed in a full draft circulating air oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under actual operating conditions, but not less than 70°C (158°F) in any case. The machine is to remain in the oven for 7 hours. After its careful removal from the oven and its return to room temperature, the machine is to be subjected to the Adequacy of Mounting Test, Section 56.

58 Permanence of Marking Tests

58.1 Marking required by this standard shall be permanent. A permanent marking shall be molded, die-stamped, paint-stenciled; stamped or etched metal that is permanently secured; or indelibly stamped on a pressure-sensitive label secured by adhesive that complies with the Standard for Marking and Labeling Systems, UL 969. Conditions to which a label may be subjected, such as ordinary usage, handling, and storage of the unit, are to be considered in determining whether a marking is permanent.

59 Accessory Installation Test

59.1 To determine compliance with 7.11, a machine shall be tested in accordance with 59.2.

59.2 The field attached accessory shall be installed in or on the machine in accordance with the installation instructions.

59A Grounding Continuity Test

59A.1 A product shall have a maximum resistance of 0.1 ohm between any part required to be connected to the grounding means and:

a) For permanently-connected products, the point on the product at which the power-supply system is to be connected; or

b) For cord-connected products, the point to which the grounding conductor of the power-supply cord is connected.

59A.2 The resistance is to be measured using a typical ohmmeter.

59A.3 When an ohmmeter yields results that do not comply with 59A.1, the resistance is to be re-measured by passing an AC or DC current between the two points at which the measurement was recorded. The current is to be equal to the maximum-current-rated branch-circuit overcurrent-protective device that is capable of being employed with the product. The resistance is to be calculated by dividing the voltage drop between the two points by the current.

MANUFACTURING AND PRODUCTION-LINE TESTS

60 Dielectric Voltage-Withstand

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

a) 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 (42.4 volts peak or less) metal parts, including terminals.

60.2 The production-line test shall be in accordance with either Condition A or Condition B of Table 60.1.

Table 60.1
Production-line test conditions

Machine rating	Condition A			Condition B		
	Potential, volts AC	Potential, volts DC	Time, seconds	Potential, volts AC	Potential, volts DC	Time, seconds
250 V or less with or without a motor rated 1/2 hp (373 W) or less	1000	1400	60	1200	1700	1
Rated more than 250 V or with a motor rated more than 1/2 hp (373 W)	1000 +2V[a]	1400 +2.8V[a]	60	1200 +2.4V[a]	1700 +3.4V[a]	1

[a] Maximum rated voltage.

60.3 The machine may be in a heated or unheated condition for the test.

60.4 The test is to be conducted when the machine is complete – fully assembled – and with the primary switch in the on position. It is not intended that the machine be unwired, modified, or disassembled for the test.

Exception No. 1: Parts such as snap covers or friction-fit knobs that would interfere with the performance of the test need not be in place.

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

Exception No. 3: The test may be conducted before a solid-state component, which can be damaged by the dielectric potential, is electrically connected. However, a random sampling of each day's production is to be tested at the potential specified in 60.2, but the circuitry may be rearranged for the test to minimize the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

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

60.6 If the output of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

60.7 If the output of the test equipment transformer is 500 VA 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) A marking in a readily visible location to indicate the test potential of equipment having a single test potential output.

If marking is used without an indicating voltmeter, the equipment shall include a positive means, such as a power-on lamp to indicate that the manually reset switch has been reset following a tripout.

60.8 Test equipment other than that described in 60.5 – 60.7 may be used if found to accomplish the intended factory control.

60.9 During the test, a sufficient number of primary switching components shall be in the on position so that all primary circuitry will be stressed. Both sides of the primary circuit of the machine are to be connected together to one terminal of the test equipment. The second test equipment terminal is to be connected to accessible metal.

Exception: A machine (resistive, high-impedance winding, or the like) having circuitry not subject to excessive secondary-voltage build-up 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.

61 Continuity Tests

61.1 Grounding

61.1.1 Each cord-connected machine having provision for grounding shall be tested, as a routine production-line test, to determine that grounding continuity exists between the grounding blade of the attachment plug and the accessible dead metal parts of the machine that are likely to become energized.

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

61.2 Polarization

61.2.1 As a routine production-line verification, each cord-connected machine provided with a 2-wire polarized or 3-wire grounding attachment plug, shall be examined or tested for electrical continuity between the ungrounded circuit supply conductor of the attachment plug (see Figure 12.1 for attachment plug blade connections) and any component intended to be connected to the ungrounded conductor. If the

continuity cannot be readily determined by visual inspection and component checking, an electrical continuity test is to be conducted.

61.3 Electrical indicating device

61.3.1 Any indicating device, such as an ohmmeter, a battery-and-buzzer combination, or the like, may be used to determine compliance with the continuity requirements in 61.1.1 and 61.2.1.

RATINGS

62 Details

62.1 A machine shall be rated in volts, in frequency– expressed in one of the following terms: hertz, Hz, cycles-per-second, cps, cycles/second, C/s, ac-dc, or ac only – and, other than as noted in 62.2, in amperes. The frequency may be expressed as ___/dc – for example, 60/dc – if a universal motor nameplate serves as the machine rating marking. If a machine is intended for use on a polyphase circuit, the number of phases shall be included in the rating.

62.2 Instead of the ampere rating mentioned in 62.1, a machine may be rated in watts if the full-load power factor is 0.80 or more.

MARKINGS

63 Details

63.1 General

63.1.1 A machine shall be clearly marked where it will be readily visible – after installation, in the case of a permanently connected machine – with:

a) The manufacturer's name, trade name, or trademark, or other descriptive marking by which the organization responsible for the product may be identified,

b) A distinctive catalog number or the equivalent,

c) The electrical rating, and

d) The date or other dating period of manufacture not exceeding any three consecutive months.

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

Exception No. 2: The date of manufacture may be abbreviated; or may be in a nationally accepted conventional code or in a code affirmed by the manufacturer, provided that the code:

a) Does not repeat in less than 20 years.

b) Does not require reference to the production records of the manufacturer to determine when the product was manufactured.

63.1.2 A machine that employs a single motor as its only electric-energy-consuming component need not show the electrical rating given on the motor nameplate elsewhere on the machine if this nameplate is readily visible after the machine has been installed.

63.1.3 If the motor nameplate of a dual-voltage motor is employed to give the electrical rating of the machine as provided in 63.1.2, the machine shall be additionally marked to indicate the particular voltage for which it is connected when shipped from the factory. If the machine employs an attachment plug, instructions shall be provided to indicate the type of plug that should be used if the machine is reconnected for the alternate voltage.

63.1.4 If a manufacturer produces or assembles a machine at more than one factory, each finished machine shall have a distinctive marking by means of which it may be identified as the product of a particular factory.

63.1.5 A machine having provisions for two or more separate connections to a branch circuit or other power-supply source shall be marked with the word "CAUTION " and the following or the equivalent "This machine has more than one connection to the source of supply. To reduce the risk of electrical shock, disconnect all such connections before servicing." The marking shall be located at each point of connection, and shall be readily visible after installation of the machine.

63.1.6 If the construction of a machine contemplates cleaning or servicing, such as the replacement of pilot lamps or fuses, by the user, and if such cleaning or servicing would involve the exposure of a normally enclosed or protected live part to unintentional contact, the machine shall be plainly marked to indicate that such servicing or cleaning be done with the machine disconnected from the supply circuit.

63.1.7 A machine that will not start and attain normal running speed when connected to a circuit protected by an ordinary – not a time-delay – fuse as described in 34.1 shall be marked with the words "If connected to a circuit protected by fuses, use time-delay fuses with this machine " or with an equivalent wording.

63.1.8 A machine shall not be marked with a double insulation symbol – a square within a square – the words "Double Insulation", or the equivalent unless it complies with the requirements for double-insulated appliances.

63.2 Permanently connected machines

63.2.1 If any point within a terminal box or wiring compartment of a permanently connected machine in which the power-supply conductors are intended to be connected, including such conductors themselves, attains a temperature rise of more than 35°C (63°F) during the normal temperature test, the machine shall be permanently marked "For supply connection, use wires acceptable for at least ___C (___F)," or with an equivalent statement, and the temperature value shall be in accordance with Table 63.1. 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 machine.

Table 63.1
Outlet-box marking

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

63.2.2 A permanently connected machine having one motor and other loads or more than one motor with or without other loads shall be permanently marked in a location that will be visible when connections to the power-supply circuit are made and inspected with:

a) The minimum supply-circuit conductor ampacity and

b) The maximum rating of the supply-circuit overcurrent-protective device.

63.2.3 A machine intended for permanent connection to a wiring system other than rigid metal conduit or armored cable shall be marked to indicate the system or systems for which it is acceptable. The marking shall be located so that it will be visible when power-supply connections to the machine are being made.

63.3 Components

63.3.1 A heating element rated more than 1 A and intended to be replaceable in the field shall be marked with its rating in volts and amperes or in volts and watts, or the manufacturer's part number.

63.4 Cautionary marking

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

63.4.2 A cautionary marking shall be located on a permanent part of the machine.

63.4.3 A cautionary marking intended to instruct the operator shall be legible and visible from the position normally assumed by the operator when starting the machine or from the position normally assumed for the specific operation involved. Other such markings for servicing or making settings and adjustments shall be legible and visible to the individual when such work is being accomplished.

63.4.4 A marking intended to inform the user of a risk of injury to persons shall be prefixed by a signal word "CAUTION," "WARNING," or "DANGER." The marking shall be in letters not less than 3/32 inches (2.4 mm) high. The signal word shall be more prominent than any other required marking on the machine.

63.4.5 If, when energized, a machine has a moving part that may cause injury to persons, a switch that controls the motor that drives the part shall have a plainly marked off position.

Exception: A momentary-contact switch need not comply with this requirement.

63.4.6 Products provided with a warning light in accordance with the Exception to 28.7 shall be marked with the following or equivalent wording:

a) "WARNING – (Flashing) Light indicates ready to operate. Avoid any contact with (specify movable parts which may start unexpectedly, such as blades)."

b) The marking required by (a) shall be located next to the warning light.

63.4.7 A blender with capacitive touch screen is required to be provided with a flashing light in accordance with 30.1(a):

a) "Flashing light indicates ready to operate. Avoid any contact with blades or moveable parts."

b) The marking required by (a) shall be located next to the flashing light.

63.4.8 When an appliance employs a dead metal part that is not grounded as provided in Exception to 16.1.3, the appliance shall be permanently marked with the word "WARNING" and the following or the equivalent: "Certain internal parts are intentionally not grounded and may present a risk of electric shock only during servicing. Service Personnel – Do not contact the following parts while the appliance is energized: (list of ungrounded parts)." The marking shall be located on the outside of the appliance where readily visible before any servicing operation, and at each approach to an ungrounded part where readily visible before or when the part becomes accessible.

Exception: If all approaches to all ungrounded parts can be adequately covered by one marking, only one marking, visible from the outside of the appliance and at the approach to the ungrounded parts, need be employed.

63.5 Attachment and accessory marking

63.5.1 The literature accompanying a package containing a basic machine and attachments intended to be marketed as a complete unit shall indicate which attachments are intended for use with the basic machine if use of such attachments exposes the user to a risk of injury.

63.5.2 If an attachment is packaged and marketed separately from the basic machine and recommended for use with it by the manufacturer of the basic machine, it shall have an assigned catalog number (or equivalent). Also, information packaged with the basic machine shall identify by catalog number, the attachments that are intended for use with the basic machine or the catalog number of the basic machine with which the attachment is intended to be used shall appear in at least one of the following locations:

a) On the attachment,

b) On the package housing the attachment, or

c) On information furnished with the attachment.

63.5.3 An electrical accessory intended for field installation in or on a machine shall be marked with the name or identifying symbol of the manufacturer or private labeler, with a catalog number or equivalent with which it is intended to be used. The machine shall be marked to indicate the catalog number or equivalent designation of such an accessory and the name of the manufacturer or private labeler of that accessory.

63.6 Specific machine markings

63.6.1 Blenders

63.6.1.1 The main portion of an open-top blender cover shall be marked with the word "CAUTION" and the following or the equivalent "Do not operate without this cover in place."

63.6.1.2 In accordance with the 29.4 Exception No. 1(a), the cover or blending jar shall be marked where visible during operation with the following, or equivalent: “CAUTION – Do Not Blend Hot Liquids”.

63.6.1.3 In accordance with the Exception No. 2 to 29.4, an open-top blender jar provided with a one-piece cover without a center opening shall include the following markings on the cover:

a) "CAUTION: Do Not Blend Hot Liquids"

b) "CAUTION: Always Operate With Cover In Place. Do Not Open Or Remove Cover When Blades Are Moving."

63.7 Machines in protected locations

63.7.1 Complete instructions shall be marked on a machine intended for use in a protected location, indicating the manufacturer's recommendations concerning the use or installation, or both, of any canopy, marquee, shelter, or similar structure, intended for the protection of the machine. The manufacturer's instructions shall be located where they are accessible without removing a panel, a cover, an accessory, a subassembly, or similar component. Manufacturer's instructions that are located inside the machine and accessible through a door on the front of the machine meet the intent of this requirement.

63.7.2 A machine shall be marked, on or adjacent to the electrical rating plate, with one of the following statements as applicable:

a) "Suitable for Protected Locations – See Installation Instructions" – if instructions are not located adjacent to marking, their location is to be specified.

b) "Suitable for Outdoor Use."

64 Accessory Installation Instructions

64.1 With reference to 7.9, instructions for installing the accessory shall be provided on or with the accessory. A statement shall be included in the instructions warning the user to disconnect the machine from the electrical supply before attempting the installation and that the accessory is intended for use only with the machine that is marked to indicate such use.

65 Instructions

65.1 In accordance with 20.3, a machine provided with an air filter intended to be replaced or cleaned shall include instructions indicating how to:

a) Determine when the filter needs replacement or cleaning;

b) Obtain a proper replacement filter; and

c) Replace or clean the filter.

Exception: The instructions need not be provided if the machine complies with the Normal Temperature Test with the filter completely (100%) blocked.

65.2 The instructions and warning statements required by 7.8, 7.9, 28.3, 63.7, 64.1, and 65.1 shall be provided as printed material. All other instructions may be provided in electronic read-only media format, such as DVD, website (accessible via URL, QR code, or similar means), flash drive or CD-ROM. If electronic media instructions are provided, the instructions and warning statements required by 7.8, 7.9, 28.3, 63.7, 64.1, and 65.1 shall also be included within the electronic media instructions.

65.3 A blender with capacitive touch screen required to be provided with a flashing light in accordance with 30.1(a), shall be provided with the following safety instruction or equivalent. "Flashing light indicates ready to operate. Avoid any contact with blades or moveable parts".

65.4 The printed instruction material referenced in 65.2 shall contain detailed instructions of how to obtain a printed copy of the material contained in electronic format.

65.5 A blender with a capacitive touch screen with a two-step ON function as specified in30.3, shall be provided with the following safety instruction or equivalent. “Unplug from outlet when not in use, before putting on or taking off parts and before cleaning. Flashing light indicates ready to operate. Avoid inadvertent contact with the touch screen”.

65.6 For a wand-type mixer provided with a Continuous ON feature as specified in the Exception to 31.1(c), the manufacturer shall provide the recommended grip points in the user instructions.

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SUPPLEMENT SA – (Normative) – EVALUATION OF ELECTRONIC CIRCUITS

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INTRODUCTION

SA1 Scope

SA1.1 Throughout this Supplement, when reference is made to requirements in "this Standard," the reference is to requirements in the main body of the Standard and not to other requirements of this Supplement.

SA1.2 These requirements provide alternate requirements for the investigation of electronic circuits and controls used in appliances covered by this standard.

SA1.3 Thermal motor protectors in direct contact with motor windings and intended for direct control of the motor supply are outside the scope of this Supplement even if they incorporate one or more electronic components.

SA2 General

SA2.1 The requirements of this Supplement are intended to apply to the electronic circuit and how it is integrated into the appliance. The overall appliance construction, performance testing and marking requirements are applicable as specified in this Standard except as specified in this Supplement.

SA3 Glossary

SA3.1 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 SCFs. See SA3.9. Control functions whose failure might result in a dangerous malfunction would include unexpected operation of the appliance where the operation would result in an increased risk of electric shock, fire or injury to persons.

SA3.2 ELECTRONIC DISCONNECTION – The de-energizing of the functional load of the appliance by an electronic device of a circuit with no air gap.

SA3.3 INTENTIONALLY WEAK PART – A part intended to rupture under conditions of abnormal operation to prevent the occurrence of a condition which could impair compliance with this standard.

SA3.4 LOW-POWER CIRCUIT – A circuit or parts of circuits farther from the supply source than a low-power point.

SA3.5 LOW-POWER POINT – A point closest to the supply source in an electronic circuit where the maximum available power to an external load at the end of 5 seconds does not exceed 15 watts.

SA3.6 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions. The function of a PEC would be considered a SCF. See SA3.9.

SA3.7 RISK OF ELECTRIC SHOCK – For indoor use appliances, a risk of electric shock is considered to exist if under normal conditions and single component fault conditions the potential between the part and earth ground or any other simultaneously accessible part is more than the following relevant values (these low-voltage circuits shall be supplied from an isolating source):

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

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

For outdoor use appliances, the voltage levels in items (a) – (d) are halved.

SA3.8 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where a power of more than 15 watts can be delivered into an external resistor connected between the two points within 5 seconds under normal conditions and single-fault conditions.

SA3.9 SAFETY CRITICAL FUNCTION (SCF) – Control, protection and monitoring functions which are being relied upon to reduce the risk of fire, electric shock or injury to persons.

CONSTRUCTION

SA4 Components

SA4.1 Capacitors

SA4.1.1 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 specified in 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. Details for damp heat, steady state test are specified in 4.12 of UL 60384-14.

SA4.2 Isolation devices

SA4.2.1 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 of 2500 volts between the input and output circuits as specified in Dielectric Voltage-Withstand Test, Section 37 in this Standard.

SA4.2.2 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 of 2500 volts for 1 minutes as specified in Dielectric Voltage-Withstand Test, Section 37 in this Standard.