UL 1240

STANDARD FOR SAFETY

Electric Commercial Clothes-Drying Equipment

UL Standard for Safety for Electric Commercial Clothes-Drying Equipment, UL 1240

Fourth Edition, Dated October 4, 2005

Summary of Topics

This revision of ANSI/UL 1240 dated September 14, 2021 includes the replacement of the reference to UL 508C, Standard for Power Conversion Equipment, with a reference to UL 61800-5-1, Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy; 20A.2.4

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated February 5, 2021 and June 18, 2021.

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UL 1240

Standard for Electric Commercial Clothes-Drying Equipment

Prior to the first edition, the requirements for the products covered by this Standard were included in the Standard for Electric Home-Laundry Equipment, UL 560. The first edition was titled Standard for Electric Coin-Operated Commercial Clothes-Drying Equipment.

First Edition – February, 1974
Second Edition – August, 1979
Third Edition – April, 1994

Fourth Edition

October 4, 2005

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through September 14, 2021.

The most recent designation of ANSI/UL 1240 as an American National Standard (ANSI) occurred on September 14, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electric commercial, industrial, and institutional clothes-drying equipment intended for use in accordance with the National Electrical Code, NFPA 70. Equipment covered by this Standard is not intended for use by the general public, but only by trained or supervised personnel.

1.2 These requirements do not cover coin-operated clothes-drying equipment, flatirons, ironing machines, water heaters, water softeners, dry-cleaning machines, garment-finishing machines, clothes washers, or other equipment covered by requirements separate from this standard.

1.3 Appliances and field-attached accessories including those that utilize some other source of energy – such as gas or steam– in addition to electric energy are investigated under these requirements and under such additional requirements as are applicable to the appliance under consideration.

2 References

2.1 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.

2.2 In the following text, a requirement that applies only to a specific class of equipment is so identified by a specific reference in that requirement to the class or classes of appliances involved. Absence of such specific reference or use of the term appliance indicates that the requirement applies to all classes of appliances unless the context indicates otherwise.

2.3 In the following text, a specific requirement pertaining to a particular appliance takes precedence over a corresponding requirement specified as being applicable to all appliances.

3 Glossary

3.1 APPLIANCE, AUTOMATIC – An appliance is considered to be automatically controlled under one or more of the following conditions:

a) If repeated starting of the appliance, 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) If, during any single predetermined cycle of operation, the motor is caused to stop and restart one or more times.

c) If, upon energizing the appliance, the initial starting of the motor may be intentionally delayed beyond normal, conventional starting.

d) If, 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.

3.2 APPLIANCE, RECESSED – An appliance intended to:

a) Be supported by the floor, and

b) Sit immediately adjacent to a wall in the rear or to sit immediately adjacent to a wall, a cabinet, or another appliance on each side.

If the construction permits, a counter top may cover the appliance and adjacent cabinets and appliances. A recessed appliance is not intended for permanent attachment to the building structure or to adjacent cabinets or appliances.

3.3 APPLIANCE, SEMI-AUTOMATIC – An appliance employing two or more motors is considered to be semiautomatically controlled if:

a) One or more motors are controlled in accordance with any of the conditions specified in 3.1, and

b) At least one motor is not controlled in accordance with any of the conditions specified in 3.1.

3.4 APPLIANCE, WALL-INSERT – An appliance intended to be mounted permanently in a wall or other vertical surface of a building or cabinet.

3.5 ENCLOSURE – The part of the product that:

a) Reduces the accessibility of all or any parts of the product that may otherwise result in a risk of electric shock or injury to persons; or

b) Retards propagation of flame initiated by electrical disturbances that may occur within the product.

3.6 PART, DECORATIVE – A part used for ornamental purposes only and not as an enclosure or as insulation of electrically live parts.

3.7 PART, FUNCTIONAL – A part that is necessary for the proper functioning of the product, and that is used in such a way that deterioration or breakage of the part would result in a risk of fire, electric shock, or injury to persons.

3.8 OPERATING CONTROL – Control, the operation of which starts or regulates the appliance during normal operation.

3.9 PROTECTIVE CONTROL – Control, the operation of which is intended to prevent the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the appliance.

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

3.11 TEMPERATURE-LIMITING DEVICE – A device that functions:

a) only under conditions that produce abnormal temperatures; and

b) that is not intended to function during normal operation of the appliance.

3.12 TEMPERATURE-REGULATING DEVICE – A device that:

a) regulates temperature; and

b) functions during normal operation of the appliance.

3.13 TEMPERATURE-REGULATING AND – LIMITING (Combination) DEVICE- A device that functions to:

a) regulates the temperature under normal conditions of use; and

b) limit abnormal temperatures that might result from conditions of abnormal operation of the appliance.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the appliances covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

4.4 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.

5 Units of Measurement

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

6 Field-Attached Accessories

6.1 The requirements in 6.2 – 6.8 apply to accessories intended for installation on or connection to an appliance for the purpose of modifying or supplementing the functions of the appliance or accessory.

6.2 An appliance that has provision for the use of an accessory to be attached in the field shall be constructed so that the use of the accessory will not introduce a risk of fire, electric shock, or injury to persons.

6.3 The installation of an accessory by the user shall be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors of other than the general-use or specific-purpose type.

6.4 The installation of an accessory by a qualified electrician or serviceman is acceptable if connections are made to existing terminals by use of wire connectors.

6.5 Accessories intended to be field wired shall be provided with a means for connection to the power supply circuit of the appliance as specified in 11.1.1.

6.6 Any installation that requires field rearrangement of components or wiring, cutting or splicing of wiring, or soldering of connections is not acceptable.

6.7 As part of the investigation, an accessory shall be tested and trial-installed to determine that installation is feasible, that the instructions are detailed and correct, and that the use of the accessory will not introduce a risk of fire, electric shock, or injury to persons.

6.8 An appliance that has provision for the field connection of an accessory and a field-attached accessory shall be marked as specified in 49.1 and 49.31 – 49.33, as applicable.

CONSTRUCTION

7 Frame and Enclosure

7.1 An appliance shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.2 An appliance shall be provided with an enclosure of material found by investigation to be acceptable for the application that shall house all parts that may present a risk of fire, electric shock, or injury to persons under any condition of use.

7.3 Among the factors that shall be taken into consideration when judging the acceptability of an enclosure material are its:

a) 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 use.

7.4 An enclosure constructed of polymeric material shall comply with the requirements in Polymeric Materials, Section 40.

7.5 For an unreinforced, flat surface, cast metal shall not be less than 1/8 in (3.2 mm) thick, malleable iron shall not be less than 3/32 in (2.4 mm) thick, die-cast metal shall not be less than 5/64 in (2.0 mm) thick.

Exception: Metal of lesser thickness but not less than 3/32 in (2.4 mm), 1/16 in (1.6 mm), and 3/64 in (1.2 mm), respectively, may be acceptable provided the surface under consideration is:

a) Curved, ribbed, or otherwise reinforced to provide mechanical strength equivalent to that required; or

b) Of a size or shape that provides mechanical strength equivalent to that required.

7.6 An enclosure of sheet metal shall be judged with respect to size, shape, thickness of metal, and acceptability for the application considering the intended use of the complete appliance.

7.7 For an enclosure of sheet metal, sheet steel shall have a minimum thickness of 0.026 in (0.66 mm), aluminum shall have a minimum thickness of 0.036 in (0.91 mm), and copper or brass shall have a minimum thickness of 0.033 in (0.84 mm).

Exception: This requirement does not apply to an area that is relatively small or a surface that is curved or otherwise reinforced.

7.8 At a point where the power-supply conductors enter the enclosure, sheet metal shall not be less than 0.032 in (0.81 mm) thick if uncoated steel, not less than 0.034 in (0.86 mm) if galvanized steel, not less than 0.044 in (1.12 mm) if aluminum, and not less than 0.043 in (1.09 mm) if copper or brass.

7.9 In an appliance as mentioned in the Exception to 7.15, provision shall be made to reduce the likelihood of molten metal, burning insulation, or the like falling upon combustible materials, including the surface on which the appliance is supported.

7.10 The requirement in 7.9 will necessitate the use of a barrier of noncombustible material:

a) Under a motor unless:

1) The structural parts of the motor or the appliance 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 appliance 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 capacitor motor short circuited – the short circuit is to be applied before the motor is energized, and the rotor is to be locked; or

3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will prevent 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.

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

7.11 The requirement in 7.9 will also necessitate that a switch, a relay, a solenoid, or the like be individually and completely enclosed.

Exception No. 1: The terminals of a switch, a relay, a solenoid, or the like need not comply with this requirement.

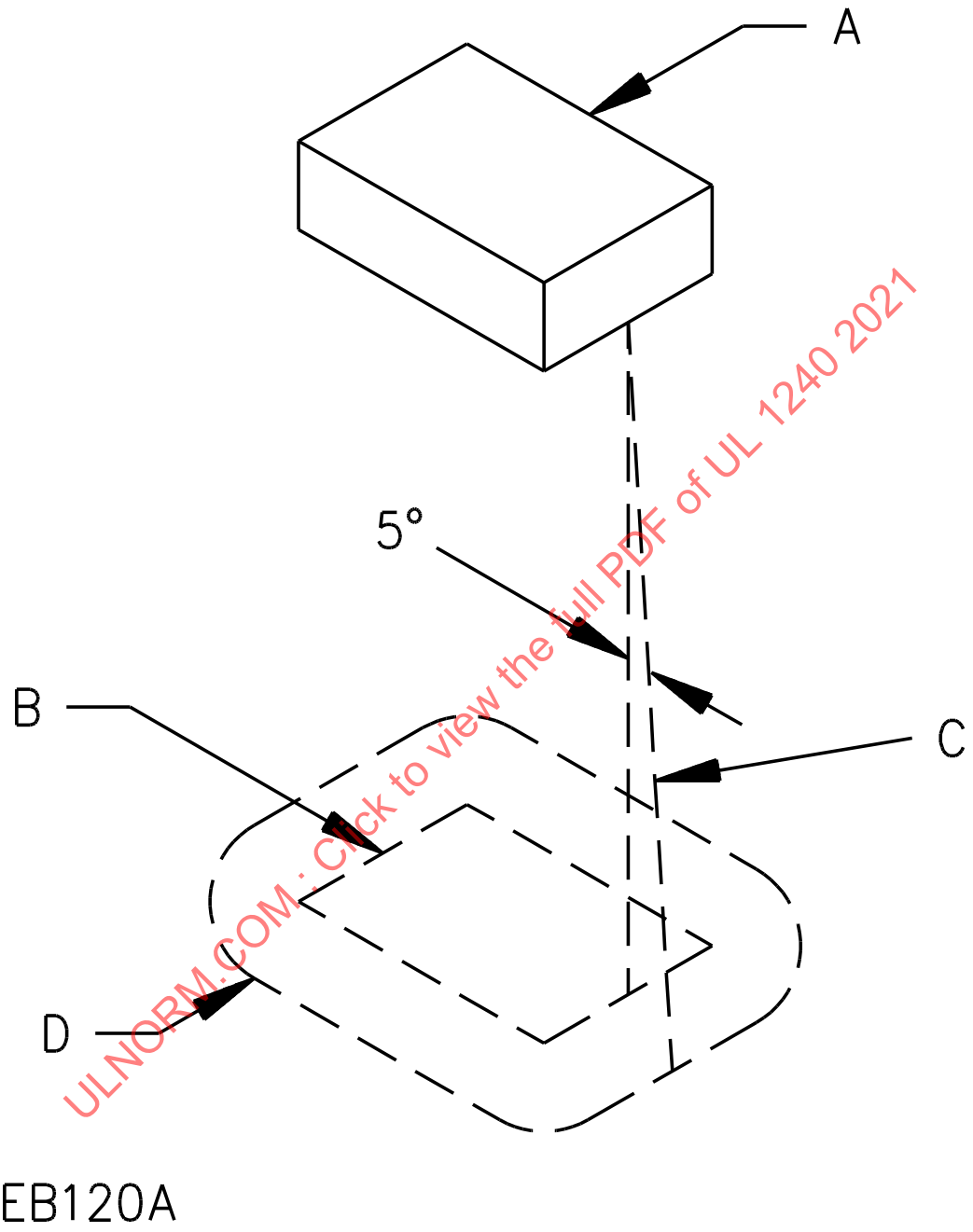
Exception No. 2: If malfunction of the component would not result in a risk of fire then such component need not comply with this requirement.

Exception No. 3: If there are no openings in the bottom of the appliance enclosure then this requirement may be waived.

7.12 The barrier mentioned in 7.10 shall be horizontal, shall be located as illustrated in Figure 7.1, and shall have an area in accordance with that illustration.

Figure 7.1

Location and extent of barrier



A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded and will consist of the unshielded portion of a component 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 tangent to the component, 5 degrees from the vertical, and so oriented that the area traced out on a horizontal plane is maximum.

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

7.13 With reference to the barrier mentioned in 7.10, openings for drainage, ventilation, or the like, may be employed in the barrier if such openings would not permit molten metal, burning insulation, or the like to fall on combustible material.

7.14 An opening in the enclosure, other than in the front of a wall-insert appliance, shall be located or provided with a barrier, baffle, or louver so as to prevent burning insulation, molten metal, or the like, from being expelled through it. A ventilating opening shall not permit the entrance of a 3/8-in (9.5-mm) diameter rod. The distance between any point on the perimeter of an opening for a hose or tube and the nearest point on the outer surface of such hose shall not be more than 1/2 in (12.7 mm), when a hose of the diameter intended for the application is centered in the opening.

7.15 A complete bottom enclosure shall be provided for a free-standing or recessed appliance beneath all wiring and other electrical components not having an individual housing or enclosure.

Exception: An appliance that is constructed so that all blowers discharge into an exhaust duct only provided:

a) All joints in the duct within the appliance are permanently airtight, and

b) The appliance is marked in accordance with 49.28.

7.16 With reference to the requirements in 7.15, a bottom enclosure is considered to be complete if:

a) No unused opening has an area of more than 1/4 in^2 (1.6 cm^2), and

b) The total area of all such openings is no more than 2 in^2 (12.9 cm^2).

7.17 In an appliance other than as mentioned in the Exception to 7.15, arcing parts of a component, such as a switch or thermostat, shall be totally enclosed.

Exception: Arcing parts of a component need not be totally enclosed if:

a) The component is located in a separate enclosure, such as a console or other enclosure located outside the enclosure surrounding the drum; and

b) The unused portion of any opening into the enclosure housing the component is not more than 0.75 in^2 (4.8 cm^2), and the total of all unused openings into that enclosure is not more than 3 in^2 (19.4 cm^2).

7.18 The bottom of the enclosure of a wall-insert appliance shall be complete and without openings.

8 Accessibility of Uninsulated Live Parts and Film-Coated Wire

8.1 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b).

a) For an opening that has a minor dimension (see 8.5) less than 1 in (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 8.1.

b) For an opening that has a minor dimension of 1 in (25.4 mm) or more, such a part or wire shall be spaced from the opening as specified in Table 8.1.

Exception: A motor need not comply with these requirements if the integral enclosure of the motor complies with the requirements in 8.2.

Table 8.1
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

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

[a] See 8.5.

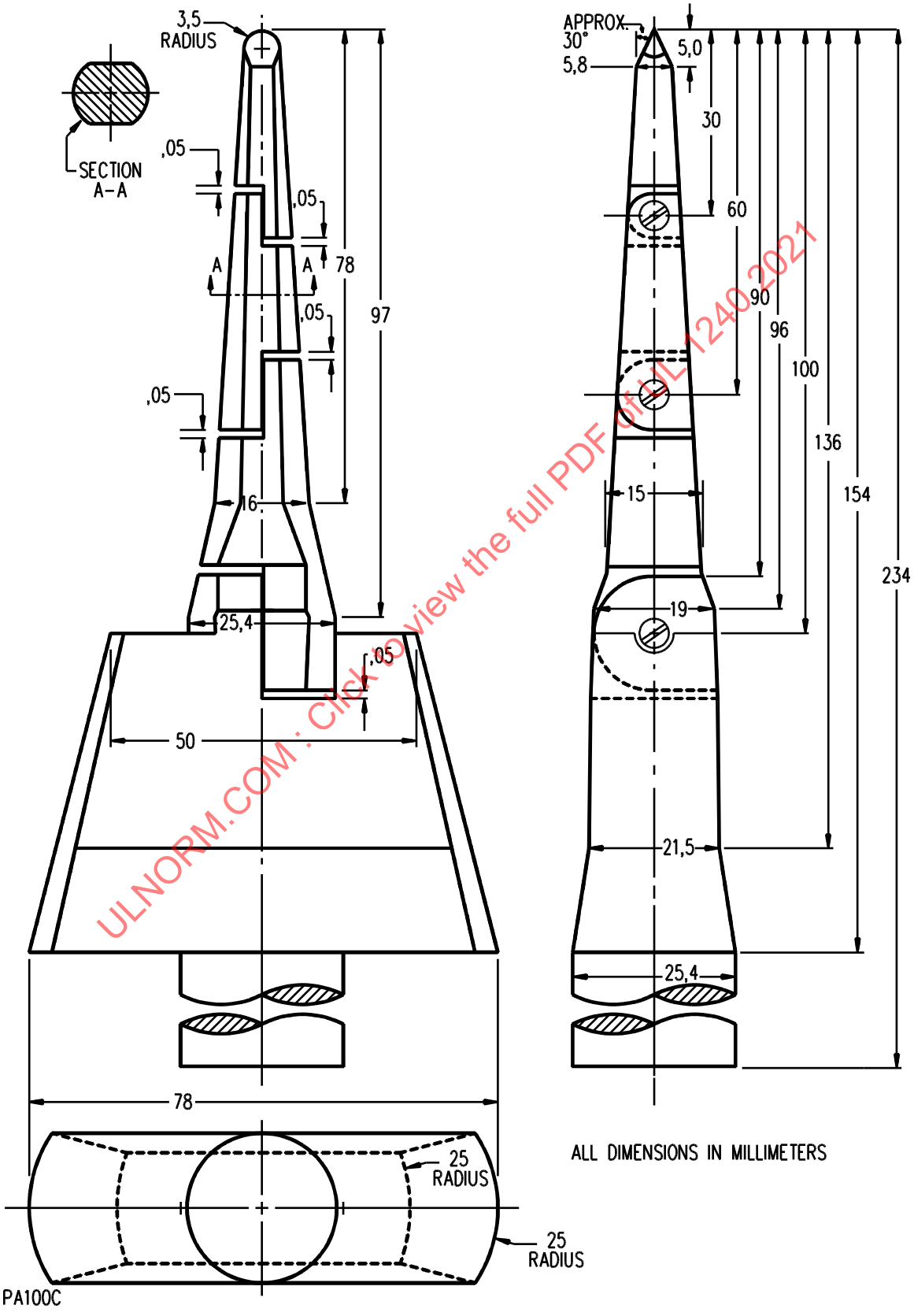
[b] Between 3/4 in (19.1 mm) and 2-1/8 in (54 mm), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 in (25.4 mm) applies to a motor only.

[d] More than 2-1/8 in (54 mm), but not more than 6 in (152.0 mm).

Figure 8.1

Articulate probe with web stop



8.2 With respect to an integral enclosure of a motor as mentioned in the Exception to 8.1:

a) An opening that has a minor dimension (see 8.5) less than 3/4 in (19.1 mm) is acceptable if:

1) Film-coated wire cannot be contacted by the probe illustrated in Figure 8.3;

2) In a directly accessible motor (see 8.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.4; and

3) In an indirectly accessible motor (see 8.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.2.

b) An opening that has a minor dimension of 3/4 in (19.1 mm) or more is acceptable if a part or wire is spaced from the opening as specified in Table 8.1.

Figure 8.2

Probe for uninsulated live parts

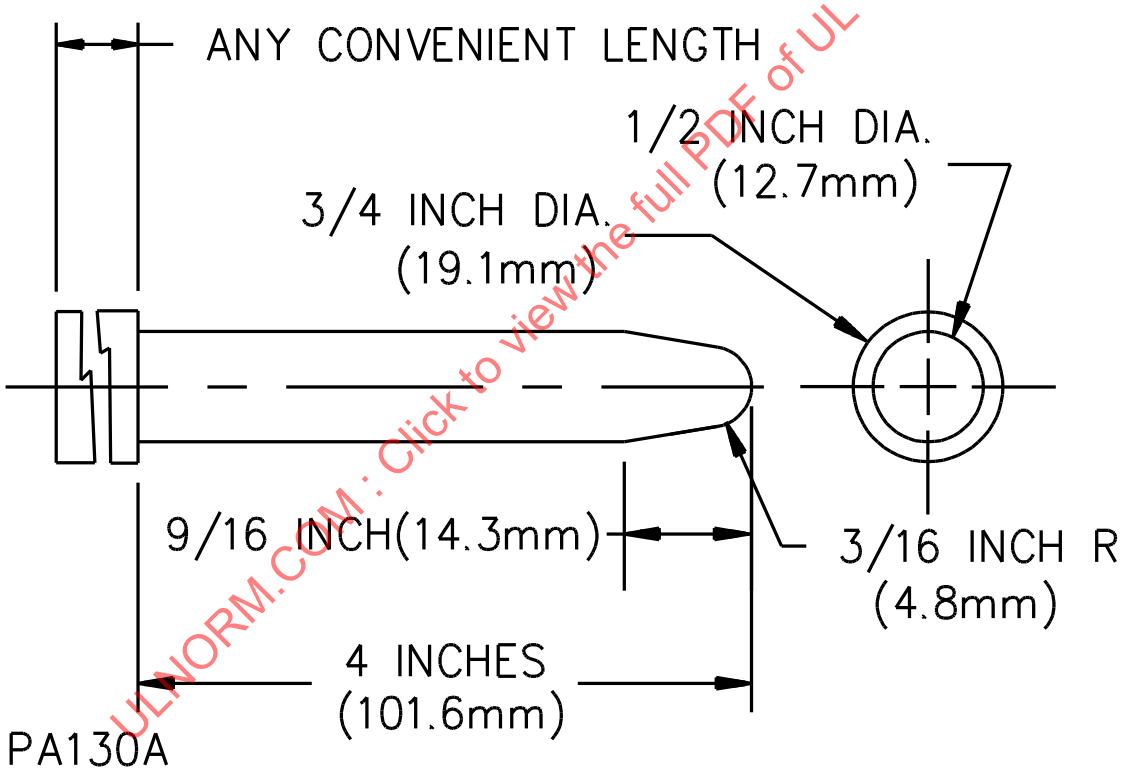


Figure 8.3

Probe for film-coated wire

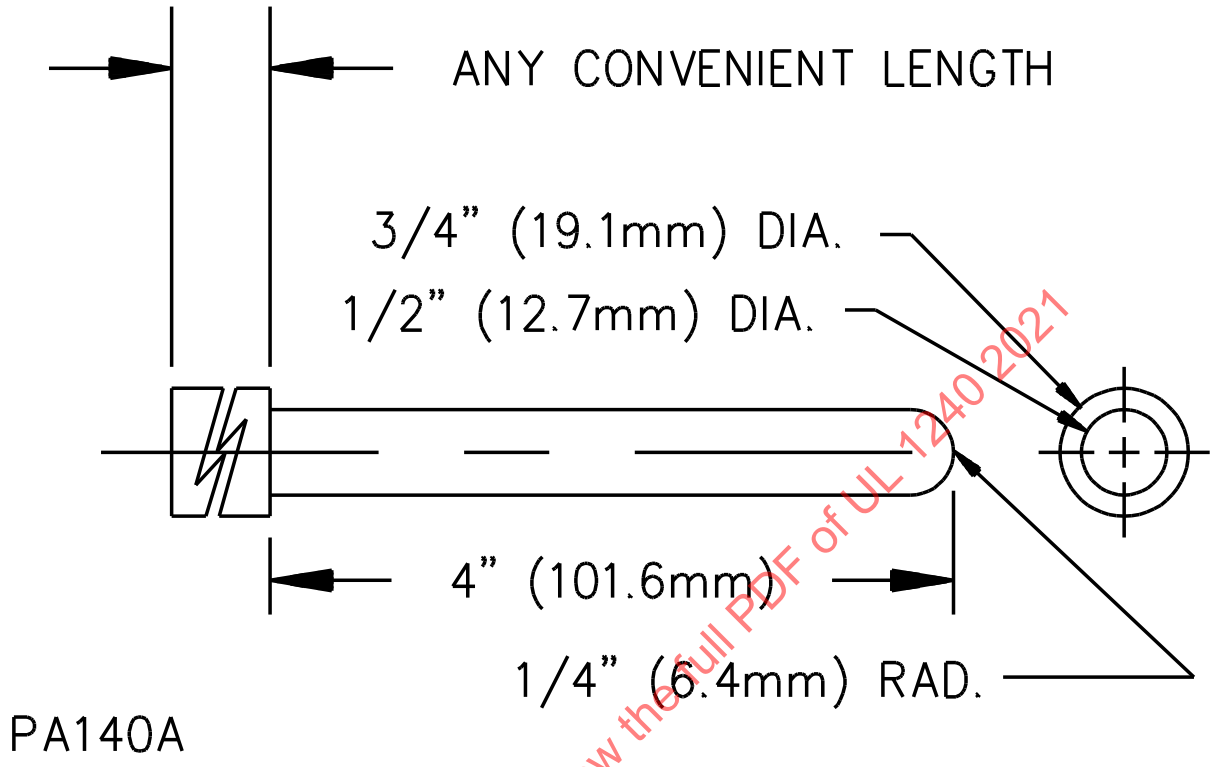
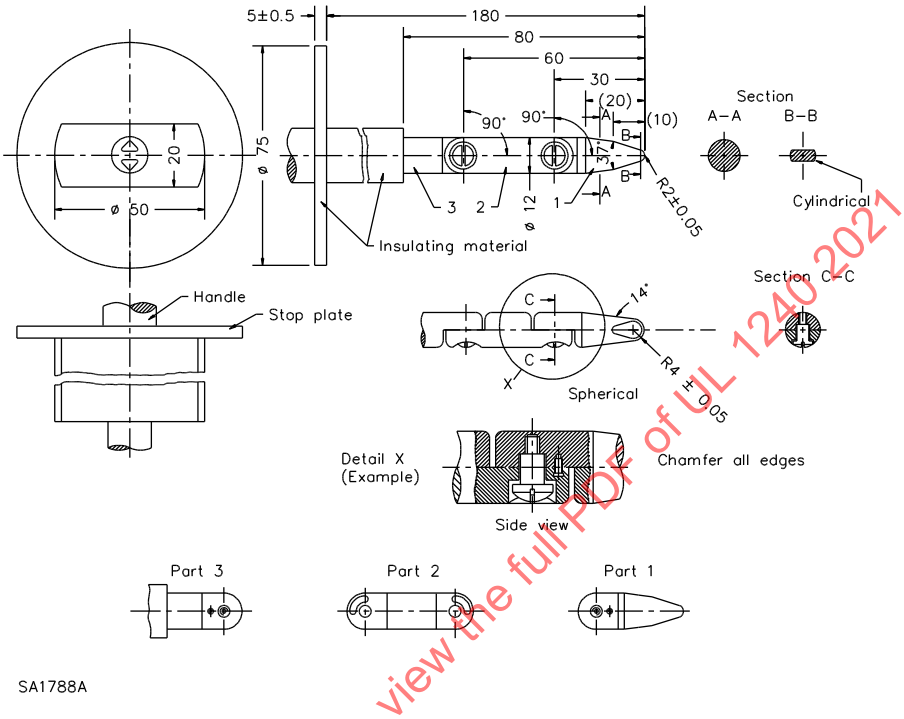


Figure 8.4

International Electrotechnical Commission (IEC) articulate accessibility probe with stop plate

All dimensions in millimeters

Courtesy of IEC



8.3 The probes mentioned in 8.1 and 8.2 and illustrated in Figure 8.1, Figure 8.2, Figure 8.3, and Figure 8.4 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figure 8.1 and Figure 8.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

8.4 The probes mentioned in 8.1 and 8.2 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

8.5 With reference to the requirements in 8.1 and 8.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

8.6 With reference to the requirements in 8.2:

a) An indirectly accessible motor is a motor that is:

1) Accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool, or

2) Located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

b) A directly accessible motor is a motor that:

1) Can be contacted without opening or removing any part, or

2) Is located so as to be accessible to contact.

8.7 With reference to the requirements in 8.1 and 8.2, insulated brush caps are not required to be additionally enclosed.

8.8 The requirements in 8.1 and 8.2 apply to the back of a free-standing appliance and to the back and sides of a recessed appliance. They do not apply to the bottom of a free-standing or recessed appliance if the front, sides, and back of the appliance extend substantially to the surface upon which the appliance rests.

8.9 A protective device, such as a fuse, the functioning of which requires renewal or replacement, shall be in a readily accessible location.

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

Exception: 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.

8.11 A door or a cover of an enclosure shall be hinged or otherwise attached in an equivalent manner if it gives access to any overload protective device, the functioning of which requires renewal, or if it is necessary to open the cover in connection with the operation of the protective device.

8.12 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.

9 Mechanical Assembly

9.1 An appliance shall be assembled so that it will not be adversely affected by the vibration of normal operation. Brush caps shall be tightly threaded or otherwise designed to reduce the likelihood of loosening.

9.2 A switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be prevented from shifting or turning.

Exception No. 1: A switch need not be prevented 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 rotate the switch during normal operation of the switch.

b) Means for mounting the switch make it unlikely that operation of the switch will loosen it.

c) Spacings are not reduced below the minimum acceptable values if the switch rotates.

d) 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 by a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

9.3 Means for preventing the rotation mentioned in 9.2 is to consist of more than friction between surfaces – for example, a properly applied lock washer may be used to prevent turning of a small stem-mounted switch or other device having single-hole mounting means.

10 Protection Against Corrosion

10.1 Surfaces of an iron or a steel part shall be protected against corrosion by enameling, galvanizing, plating, or other means that provide equivalent protection.

Exception No. 1: Bearings, balance weights, laminations, or minor parts of iron or steel such as washers, screws, and the like.

Exception No. 2: A part of iron or steel if corrosion or breakage of such a part is not likely to result in a risk of fire, electric shock, or injury to persons.

11 Power-Supply Connections

11.1 General

11.1.1 An appliance shall be provided with wiring terminals or leads for the connection of conductors that will be connected in the field and means for connection of a wiring system.

Exception: An appliance other than a wall-insert type may be provided with a flexible cord and an attachment plug for connection to the supply circuit.

11.1.2 A field-wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless the wire and means of making the connection, such as a pressure wire connector, soldering lugs, soldered loop, crimped eyelet, or the like, factory-assembled to the wire, are provided as a part of the appliance.

11.2 Permanently connected appliances

11.2.1 Terminal compartments

11.2.1.1 An outlet or terminal box in which connections to the supply circuit will be made shall be located so that, after the appliance has been installed as intended, such connections will be readily accessible for inspection.

11.2.1.2 The requirement in 11.2.1.1 necessitates that the terminal box of a wall-insert appliance be located so that it will be accessible without the necessity of moving the appliance after installation.

11.2.1.3 If it is intended that the supply connections be made to the motor of an appliance, 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.

11.2.2 Wiring terminals and leads

11.2.2.1 Wiring terminals or leads intended for connection of the conductors of the supply circuit shall be acceptable for the connection of conductors having an ampacity not less than the rating of the branch circuit marked on the appliance.

11.2.2.2 A wiring terminal shall be provided with a soldering lug or with a pressure wire connector securely fastened in place – for example, firmly bolted or held by a screw. A connection device that depends on solder shall not be used for the connection of an equipment-grounding conductor.

Exception: A wire-binding screw 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 position.

11.2.2.3 A wiring terminal shall be prevented from turning.

11.2.2.4 A wire-binding screw shall thread into metal.

11.2.2.5 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

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

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

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

11.2.2.7 A terminal plate may have the metal extruded at the tapped hole to give the thickness necessary for not less than two full threads provided the thickness of the unextruded metal is not less than the pitch of the thread.

11.2.2.8 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 11.2.2.1, but not smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

11.2.2.9 The free length of a lead inside an outlet box or wiring compartment shall be 6 in (150 mm) or more if the lead is intended for field connection to an external circuit.

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

11.2.2.10 An appliance designed so that it may be adapted upon installation for either of two different supply voltages– for example, 120 V, 2-wire or 120/240 V, 3-wire – shall be provided with a terminal block or board on which the appropriate connections may be made during field installation, without the necessity of changing or disrupting internal wiring or connections other than at the terminal block. See 49.20.

11.3 For connection of grounded power-supply conductor

11.3.1 An appliance provided with wiring terminals or leads and rated 125 V or 125/250 V or less and employing a lamp- or element-holder of the Edison-screw-shell type, a single-pole switch, or a single-pole automatic control shall have one terminal or lead identified for connection of the grounded conductor of a supply circuit. The terminal or lead intended to be connected to a grounded conductor of a supply circuit shall be the one that is connected to screw shells of lamp- or element-holders, and to which are connected no single-pole switches or single-pole automatic controls.

Exception: An auxiliary control as mentioned in 22.1 need not comply with this requirement.

11.3.2 A terminal for connection of the grounded conductor of a supply circuit shall be of or plated with a metal substantially white in color. Such a terminal shall be readily distinguishable from the other terminals; or identification of the terminal shall be clearly shown in some other way, such as on an attached wiring diagram.

11.3.3 The terminal of a nominal 120/240-V, 3-wire appliance for connection of the grounded conductor of a supply circuit shall be capable of securing a 10 AWG (5.3 mm^2) or larger conductor.

11.3.4 A lead for connection of the grounded conductor of a supply circuit shall have a white or gray color and shall be readily distinguishable from the other leads.

11.4 For connection of equipment-grounding conductor

11.4.1 A wiring terminal for connection of an equipment-grounding conductor shall be provided. See 11.2.2.2, 11.2.2.6, and 11.2.2.7.

11.4.2 A terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size necessary for the application. See 11.3.3.

11.4.3 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector intended solely for the connection of such a conductor shall be marked in accordance with 48.7. The wire-binding screw or pressure wire connector shall be located so that it does not require removal during normal servicing of the appliance. A sheet-metal screw shall not be used for connection of an equipment-grounding conductor.

11.4.4 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 leads shall be so identified.

11.5 Cord-connected appliances

11.5.1 Cords and plugs

11.5.1.1 The flexible cord shall have an ampacity not less than the current rating of the appliance.

11.5.1.2 An attachment plug shall have an ampacity not less than the rated current of the appliance, and shall have a voltage rating not less than the rated voltage of the appliance.

11.5.1.3 Flexible cord provided with an appliance shall be Type SJ, SJO, SJT, SJTO, S, SO, ST, STO, SRD, SRDT, HSJ, HSJO, HSJOO, SJOO, SJTOO, SOO, or STOO.

11.5.1.4 For an appliance rated 120/240 V, 3-wire or one rated 120 V, 2-wire and more than 15 A, the flexible cord shall not be less than 3 ft (0.91 m) and not more than 6 ft (1.83 m) long measured from the face of the attachment plug to the point of entrance into the appliance.

11.5.1.5 For an appliance rated 120 V, two-wire and 15 A or less, the flexible cord shall not be less than 6 ft (1.83 m) long measured as described in 11.5.1.4.

11.5.1.6 The flexible cord shall be prevented from being pushed into the appliance through the 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 rated; or may reduce spacings, such as to a metal strain-relief clamp, below the minimum acceptable values.

11.5.2 Strain relief

11.5.2.1 A flexible cord shall be provided with strain relief so that stress on the cord will not be transmitted to terminals, splices, or internal wiring. The strain-relief means shall comply with the requirements in Strain Relief, Section 42.

11.5.2.2 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, that may cause abrasion of the insulation of the cord.

11.5.3 Cord bushings

11.5.3.1 The edges of the entry hole for the power-supply cord, including the cord-entry hole in a bushing, shall be smooth and free from burrs, fins, or sharp edges.

11.5.3.2 If an insulating bushing is provided where the power-supply cord enters the enclosures, and if the bushing is of material other than ceramic, phenolic or cold-molded composition, fiber, or other material that has been investigated and found to be acceptable for the application, the hole in the metal in which the bushing is mounted shall be smooth and free from burrs, fins, or sharp edges.

12 Internal Wiring

12.1 For the purpose of these requirements, the internal wiring of an appliance is considered to be all the interconnecting wiring beyond the point where the power-supply cord of a cord-connected appliance enters the enclosure, or beyond the wiring terminals or leads for power-supply connection of a permanently connected appliance, even though some of such wiring may not be completely enclosed and even though some of it may be in the form of flexible cord.

12.2 The internal wiring and connections between parts of an appliance shall be protected or enclosed. A length of flexible cord may be employed for an external – unenclosed – connection between such parts if flexibility is necessary.

12.3 The protection of insulated wiring required by 12.2 is considered to exist if, when judged as though it were enameled wire, the wiring would be acceptable according to 8.2. 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.

12.4 Unless it is to be judged as an uninsulated live part, insulated internal wiring of an appliance, including a grounding conductor, shall consist of wire that is acceptable for the application, when considered with respect to:

a) The temperature voltage to which the wiring may be subjected;

b) Exposure to oil, grease, or other substances that may have a deleterious effect on the insulation;

c) Exposure to moisture; and

d) Other conditions of service to which it may be subjected.

12.5 If the wiring inside an appliance is located so that it may be in proximity to combustible material or may be subjected to mechanical damage, it shall be in armored cable, rigid metal conduit, electrical metallic tubing, or otherwise protected.

12.6 Wiring shall be protected from sharp edges – including screw threads – burrs, fins, moving parts, and other agencies that may cause abrasion of the insulation on conductors.

12.7 A hole through which insulated wire pass in a sheet-metal wall within the overall enclosure of an appliance shall be provided with a smooth, rounded bushing of one of the materials mentioned in 11.5.3.2; or shall have smooth surfaces, free of burrs, fins, sharp edges, and the like, upon which the wires may bear, to reduce the risk of abrasion of the insulation.

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

12.9 All splices and connections shall be mechanically secure and shall provide reliable electrical contact.

12.10 A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of fire, electric shock, or injury to persons.

12.11 A wire-binding screw or nut shall be provided with a lock washer under the head of the screw or under the nut to prevent it from becoming loosened due to vibration, if such loosening may result in a risk of fire, electric shock, or injury to persons.

12.12 An open-end spade lug may not be used unless additional means are provided to hold the lug in place should the wire-binding screw or nut become loosened.

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

12.14 If the voltage involved is less than 250 V, insulation consisting of two layers of friction tape, of two layers of thermoplastic tape, or of one layer of friction tape on top of one layer of rubber tape, may be used on a splice. 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, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable.

12.15 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will be prevented from contacting other live parts not always of the same polarity as the wire and from contacting dead metal parts. This may be accomplished by use of pressure wire connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other equivalent means.

13 Live Parts

13.1 Current-carrying parts shall be of silver, copper, a copper alloy, or other material that has been investigated and found to be acceptable for the purpose.

13.2 Plated iron or steel may be used for a current-carrying part:

a) The temperature of which during normal operation is more than 100°C (212°F);

b) Within a motor or associated governor; or

c) If acceptable in accordance with 4.2;

but unplated iron or steel may not be used. Stainless steel and other corrosion-resistant alloys may be used for a current-carrying part regardless of temperature.

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

13.4 Friction between surfaces is not acceptable as the sole means to prevent the turning of live parts, but a properly applied lock washer may be used for this purpose.

14 Electrical Insulation

14.1 An insulating washer, bushing, and the like, and the base or support for the mounting of a live part shall be of a moisture-resistant material that will not be damaged by the temperatures to which it will be subjected under conditions of actual use – for example, porcelain, phenolic, cold-molded composition, or other material that has been investigated and found to be acceptable for the application.

14.2 Insulating material employed in an appliance is judged with respect to the application. Materials such as mica, some molded compounds, and certain refractory materials usually may be used as the sole support of live parts; and some other materials that are not acceptable for general use, such as asbestos and magnesium oxide, may be acceptable if used in conjunction with other acceptable insulating materials or if located and protected so that mechanical damage and the absorption of moisture are prevented. If an investigation is necessary to determine whether a material is acceptable, consideration is to be given to its mechanical strength, dielectric characteristics, insulation resistance, heat-resistant qualities, the degree to which it is enclosed or protected, and any other features that have a bearing on the risk of fire, electric shock, and injury to persons, in conjunction with the conditions of actual service.

14.3 A screw or other fastening used to mount or support a small, fragile, insulating part shall not be so tight as to crack or break such a part due to expansion and contraction. Generally, such a part should be slightly loose.

14.4 Ordinary vulcanized fiber may be used for an insulating bushing, a washer, a separator, and a barrier, but not as the sole support for an uninsulated live part if shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Thermoplastic materials are not considered to be acceptable generally for the sole support of an uninsulated live part, but may be employed if shown to be acceptable by investigation.

14.5 A small molded part, such as a terminal block, shall have such mechanical strength and rigidity that it will withstand the stresses of actual service.

15 Thermal Insulation

15.1 Combustible or electrically conductive heat-insulating material shall not be located so that it contacts an uninsulated live part.

15.2 With reference to 15.1, some types of mineral-wool thermal insulation contain conductive impurities in the form of slag that may present a risk of fire or electric shock if in contact with an uninsulated live part.

16 Motors

16.1 A motor shall be acceptable for the application, and shall be capable of driving the maximum normal load of the appliance without introducing a risk of fire, electric shock, or injury to persons.

16.2 A motor winding shall be such as to resist the absorption of moisture, and shall be formed and assembled in a workmanlike manner.

17 Overcurrent Protection

17.1 If an appliance includes one or more attachment-plug receptacles intended for general use, and if the overcurrent protection of a branch circuit to which the appliance will properly be connected will be inadequate for the receptacle or receptacles, each receptacle circuit shall have overcurrent protection rated not more than 20 A provided as a part of the appliance.

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

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

17.4 A fuseholder shall be designed and installed so that an uninsulated live part other than the screw shell or clips will not be exposed to contact by persons removing or replacing fuses.

17.5 Fuses employed for motor-overload protection shall be located in each ungrounded conductor; and in the case of a 3-phase, 3-wire, alternating-current motor, they shall be located in each of the three phases.

17.6 Devices employed for motor-overload protection, other than those that are inherent in a motor, shall be located in an ungrounded conductor of each phase.

17.7 If an appliance is provided with means for automatically disconnecting itself from the power-supply circuit, motor-overload protection that complies with the requirements in 17.9 or 17.10 shall be incorporated in the appliance.

17.8 In an appliance that will be connected to a branch circuit rated more than 30 A, overcurrent protection shall be provided for the control circuits.

17.9 The overload protection provided for a motor in an appliance having a capacity less than 25 lb (11.3 kg) and required to have such protection shall comply with one of the following items:

a) The requirements in 41.1 – 41.10.

Exception: A motor that only drives a direct-drive fan or blower intended to move air only is not required to have running overload protection.

b) The applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3.

Exception: As provided in the Exception to (a).

c) The requirements for impedance protection in the Standard for Impedance Protected Motors, UL 1004-2, when the motor is tested as used in the appliance under stalled rotor conditions.

d) Motors employing electronic protection complying with the Standard for Electronically Protected Motors, UL 1004-7, or evaluated to the tests of UL 1004-3 and the requirements of Supplement SA. See SA1.3.

17.10 The overload protection provided for a motor in an appliance having a capacity of 25 lb (11.3 kg) or more and required to have such protection shall comply with one of the following items:

a) The requirements in 41.1 – 41.10.

Exception: A motor that only drives a direct-drive fan or blower intended to move air only is not required to have running overload protection.

b) The applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3 .

Exception: As provided in the Exception to (a).

c) The requirements for impedance protection in the Standard for Impedance Protected Motors UL 1004-2 , when the motor is tested as used in the appliance under stalled rotor conditions.

d) The requirements in 41.11 and 41.12.

e) Motors employing electronic protection complying with the Standard for Electronically Protected Motors, UL 1004-7, or evaluated in accordance with Evaluation of Electronic Circuits, Supplement SA. See SA1.3.

18 Lampholders

18.1 An Edison-base lampholder of a permanently connected appliance or an appliance equipped with a polarized attachment plug shall be wired so that the screw shell will be connected to the terminal or lead that is intended for the connection of the grounded conductor of a supply circuit.

18.2 A lampholder shall be designed or installed so that uninsulated live parts other than a screw shell will not be exposed to contact by persons removing or replacing lamps in normal service.

Exception: This requirement does not apply if it is necessary to dismantle the appliance or remove a cover plate or other part by means of a tool in order to remove or replace a lamp.

19 Receptacles

19.1 An attachment-plug receptacle intended for general use shall be of the grounding type.

19.2 The face of a receptacle shall:

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

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

20 Switches

20.1 A switch shall be acceptable for the application, and shall have a current and voltage rating not less than that of the load that it controls when the appliance is operated normally.

20.2 A switch shall be located or protected so that it will not be exposed to mechanical damage during normal use.

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

20.4 A switch controlling one or more heating elements of an appliance provided with a polarized attachment plug or a permanently connected appliance shall be arranged so that opening of the switch will disconnect all the ungrounded conductors of the supply circuit.

Exception: If no live part is exposed to unintentional contact when the switch is open, or if the fact that such a part is live is definitely apparent.

20.5 A switch or other device that controls a motor and that has not been investigated for the purpose shall comply with the requirements in 39.1.

20.6 A switch or other device that controls a solenoid, relay coil, or the like and that has not been investigated for the purpose shall comply with the requirements in 39.3.

20.7 If a cord-connected appliance employs a motor rated more than 1/3 hp (249 W output), a controller for the motor shall be provided in the appliance. See 24.8.

20A Controls

20A.1 General

20A.1.1 Components, wiring, printed wiring assemblies, insulating material, potting materials, and the like, and associated circuitry employed in controls, shall be investigated and found acceptable for the application in accordance with the specified component standards with respect to a risk of fire, electric shock, and injury to persons.

20A.1.2 Controls shall be so located or protected that they are not subjected to mechanical damage, excessive moisture, or excessive collection of lint.

20A.1.3 The operating mechanism of controls shall not subject electrical parts to undue strain.

20A.1.4 Electronic circuits that manage a Safety Critical Function (SCF) shall be:

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

b) Not susceptible to electromagnetic environmental stresses encountered in the anticipated environments where the appliance will operate.

20A.2 Operating controls

20A.2.1 An operating control shall comply with:

a) Evaluation of Electronic Circuits, Supplement SA; or

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

20A.2.2 The cycle selection control, temperature-regulating devices and any control not relied upon to provide a required safety function are considered and to be tested and evaluated as operating.

20A.2.3 The minimum test parameters for the evaluation of an operating control to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and any applicable Part 2 are specified in Table 20A.1.

Table 20A.1
Operating control correlation table

(See 20A.2)

Information	Operating control requirement
FMEA	Conduct a failure-mode and effect analysis (FMEA) to identify components the failure of which may result in a risk of fire or electric shock or injury to persons.
Operating ambient	Determined in accordance with Section 36, Temperature Test, of the appliance
Endurance testing for electromechanical devices	6,000 cycles, or 100,000 cycles for temperature-regulating thermostats (see 38.5)
Overvoltage Category	Overvoltage Category II
Pollution degree	See 24A.4

20A.2.4 As an alternative to the requirements in 20A.2.1, power conversion equipment intended to control a variable speed motor load (e.g. a variable frequency drive) can comply with the Standard for Power Conversion Equipment, UL 508C or the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1. See Section 17 for the motor-overload protection requirements.

20A.3 Controls that manage safety critical functions (protective controls)

20A.3.1 A control that manages a SCF shall comply with the requirements of:

a) Evaluation of Electronic Circuits, Supplement SA; or

b) The requirements in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the relevant Part 2 applicable to a Protective Control.

20A.3.2 Controls that manage a SCF shall also be evaluated for reliability in accordance with:

a) Evaluation of Electronic Circuits, Supplement SA; or

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

20A.3.3 Electronic motor protection shall be evaluated in accordance with 17.9(d), or 17.10(e).

20A.3.4 Controls that manage a SCF and that does not rely on software, shall comply with the standards specified in 20A.3.2 except for Controls Using Software, H.11.12, in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1. If software is relied upon to perform the protective control function, it shall be considered Software Class B as indicated in Table 20A.2.

Table 20A.2
Protective control correlation table

(See 20A.3)

Information	Protective control requirement
FMEA	Conduct a failure-mode and effect analysis (FMEA) identifying component failures which may result in a risk of fire, electric shock or injury and confirming the protective function continues to operate as intended.
Operating ambient	Determined in accordance with Section 36, Temperature Test, of the appliance.
Endurance testing for electromechanical devices	a) 6,000 cycles for controls as indicated in 20A.5, 20A.6, 20A.7, and for manual, non-self-resetting temperature-limiting devices (see 38.6), and other manual, non-self-resetting protective controls. b) 100,000 cycles, for automatic, self-resetting temperature-limiting controls, combination temperature-limiting and regulating controls, and other automatic, self-resetting protective controls (see 38.6)
Overvoltage category	Overvoltage Category II
Pollution degree	See 24A.4
Radio-frequency electromagnetic field immunity to conducted disturbances	Test Level 3
Radio-frequency electromagnetic field immunity to radiated electromagnetic fields	Field strength of 3 V/m

Table 20A.2 Continued on Next Page

Table 20A.2 Continued

Information	Protective control requirement
Fast transient bursts	Test Level 3 applied for 1 minute in each polarity
Surge immunity	Installation Class 3
Electrostatic discharge	Severity Level 3
Thermal cycling for electronic devices	14 days, Assumed temperature range: 10.0 +2 °C to the operating ambient
Software class	Software Class B (See 20A.3.4)

20A.3.5 A door interlock, door lock, secondary function control, electronic braking means, motor overload protection, temperature-limiting devices, combination temperature-regulating and -limiting devices, and any control relied upon for compliance with abnormal operation testing requirements shall be tested and evaluated as a control managing a SCF in accordance with the applicable requirements in Evaluation of Electronic Circuits, Supplement SA.

20A.3.6 The minimum test parameters for the evaluation of a control managing a SCF (protective control to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1) and the relevant Part 2 are specified in Table 20A.2.

20A.4 Temperature-regulating and temperature-limiting devices

20A.4.1 A temperature sensing device, such as a positive temperature coefficient (PTC) thermistor and a negative temperature coefficient (NTC) thermistor, that is used in combination with an electronic control and that together with the control manages a SCF shall comply with the Standard for Thermistor-Type Devices, UL 1434.

20A.4.2 Protective temperature sensing controls shall have cut-in and cut-out temperatures that do not:

a) Deviate from the manufacturer's specified limits in the as-received condition by more than either 6°C or 5 percent, whichever is greater; and

b) Drift from the temperatures measured in the as -received condition by more than either 6°C or 5 percent, whichever is greater, after being subjected to the specified number of cycles in accordance with Table 20A.2 and, for electronic protective controls, the environmental stress tests in Section H.26 of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

20A.4.3 With respect to 20A.4.2, if a manufacturer declares a tighter tolerance, the deviation and drift shall remain within the manufacturer's declared values.

20A.5 Cycle selection controls

20A.5.1 Clock-operated switches incorporating mechanical clockwork, such as gears, springs, and motors, shall comply with the applicable requirements in one of the following standards:

a) Evaluation of Electronic Circuits, Supplement SA; or

b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

20A.5.2 A cycle selection control incorporating electronic timing or switching circuits, shall comply with the standards specified in 20A.2.1(b).

20A.6 Door/lid interlock or lock protective controls

20A.6.1 If a door-actuated or lid-actuated switch is employed to directly disconnect power to the motor, the switch shall comply with the Endurance Test as specified in 30.5 and with the applicable requirements in one of the following standards:

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

b) Standard for Industrial Control Equipment, UL 508.

20A.6.2 If a door-actuated or lid-actuated switch is employed as a sensor for an electronic control to disconnect power to the motor, the switch and control shall comply with 20A.3.

20A.6.3 Endurance testing of a door or lid interlock and the associated braking means shall be conducted in accordance with 30.5.

20A.7 Water level detection controls

20A.7.1 If a switch is employed as part of a water level detection mechanism, it shall comply with the applicable requirements in one of the following standards:

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

b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Air Flow, Water Flow and Water Level Sensing Controls, UL 60730-2-15.

20A.7.2 If a pressure or flow switch is employed as part of a water level detection mechanism, the switch shall comply with Flooding of Live Parts, Section 39 for gaskets or seals in contact with laundry detergent or bleach, Polymeric Materials, Section 44 for polymeric materials in contact with laundry detergent or bleach, and with the applicable requirements in one of the following standards:

a) Standard for Industrial Control Equipment, UL 508;

b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6; or

c) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Air Flow, Water Flow and Water Level Sensing Controls, UL 60730-2-15.

21 Heating Elements

21.1 The voltage rating of a heating element employed in an appliance shall not be:

a) Less than 110 V if connected in a circuit in which the potential across the heating element is a nominal 120 V.

b) Less than 191 V if connected in a circuit in which the potential across the heating element is a nominal 208 V.

c) Less than 220 V if connected in a circuit in which the potential across the heating element is a nominal 240 V.

d) Less than 254 V if connected in a circuit in which the potential across the heating element is a nominal 277 V.

e) Less than 440 V if connected in a circuit in which the potential across the heating element is a nominal 480 V.

f) Less than the voltage rating of the circuit if connected in a circuit in which the potential across the heating element is more than 480 V.

21.2 A sheathed heating element in an appliance shall comply with the requirements in the Standard for Sheathed Heating Elements, UL 1030, where applicable.

21.3 A heating element shall be supported in a substantial and reliable manner, and shall be protected against mechanical damage and contact with outside objects.

21.4 An appliance shall be constructed so that the clothes load will be positively and reliably confined to the drum or basket, and cannot contact heating elements and other parts operating at temperatures that could cause ignition of fabric.

21.5 An appliance in which the heating element is designed for operation only in an air stream shall be wired or controlled so that the element can be operated only when under the cooling effect of the stream. An appliance in which the cooling effect of the motion of a part is necessary so that excessive temperatures are not attained shall be wired or controlled so that the heating element cannot be operated in the absence of such motion.

22 Automatic Temperature Controls

22.1 An auxiliary control device in an appliance shall disconnect all heating elements that it controls from all ungrounded conductors of the supply circuit.

Exception: This requirement does not apply if no live part is exposed to unintentional contact when the auxiliary control device is open, or if the fact that such a part is live is definitely apparent.

22.2 An auxiliary control is considered to be one that is intended primarily for time, temperature, pressure regulation, and the like under conditions of normal operation, and not to reduce the risk of overload or excess-temperature conditions resulting from abnormal operation.

22.3 *Deleted*

22.4 *Deleted*

22.5 *Deleted*

23 Capacitors

23.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line, such as a capacitor for elimination of radio-frequency interference, shall be housed within an enclosure or container that will protect the plates against mechanical damage and that will prevent the emission of flame or molten material resulting from malfunction of the capacitor. The construction shall comply with one of the following:

a) The capacitor container or enclosure shall be of sheet steel not less than 0.020-in (0.51-mm) thick, or shall be constructed to afford equivalent protection;

b) A capacitor having a sheet steel container or enclosure thinner than 0.020 in (0.51 mm) or of other material shall be mounted in an enclosure that houses other parts of the appliance and that is acceptable for the enclosure of live parts.

23.2 If a capacitor that is not part of a permanent-split-capacitor motor or a part of a capacitor-start motor is connected in an automatic appliance so that capacitor malfunction would result in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the appliance to reduce the likelihood of such a condition.

23.3 The total capacitance of capacitors connected from one side of the line to the frame or enclosure of an appliance shall not permit the flow of more than 5 mA in the grounding conductor.

23.4 The voltage rating of a capacitor, other than a motor-starting capacitor, shall not be less than the maximum steady-state potential to which the capacitor is subjected during operation of the appliance.

24 Spacings

24.1 The spacings at wiring terminals shall not be less than the values specified in Table 24.1. See 11.1.2 and 24.9.

Table 24.1
Spacings at wiring terminals

Potential involved, V	Minimum spacings, in (mm)					
	Between wiring terminals of opposite polarity, and between a wiring terminal and a dead metal part other than the enclosure				Between a wiring terminal and the enclosure, through air or over surface	
	Through air		Over surface			
250 or less	1/4	(6.4)	3/8	(9.5)[a]	1/2	(12.7)[a]
More than 250	3/8	(9.5)	1/2	(12.7)[b]	1/2	(12.7)[b]

[a] If a terminal box is provided for field-wiring connections and the box is integral with the motor, a spacing of not less than 1/4 in (6.4 mm) is acceptable.

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

24.2 Except as noted in 24.5 and 24.6, the spacings between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead metal part, other than at wiring terminals, in a motor circuit, or inside a motor, shall not be less than the values specified in Table 24.2. 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 acceptable minimum spacing will be maintained. See 24.9.

Table 24.2
Spacings at other than wiring terminals, in a motor circuit, or inside a motor

Potential involved, V	Minimum through air or over surface spacings,	
	in	(mm)
0 – 125	1/16	(1.6)
126 – 250	3/32	(2.4)[a]
251 – 600	1/4	(6.4)

[a] Spacings not less than 1/16 in (1.6 mm) are acceptable at a heating element.

24.3 Except as noted in 24.1, 24.4, 24.5, and 24.6, the spacing between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead metal part in a motor circuit but not including the inside of the motor, shall not be less than the value specified in Table 24.3. 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 acceptable minimum spacing will be maintained. See 24.9.

Table 24.3
Spacings in a motor circuit other than inside the motor

Potential involved, V	Minimum spacings, in (mm)							
	Appliance employing a motor having a diameter 7 in (178 mm) or less[a]				Appliance employing a motor having a diameter more than 7 in (178 mm) through 11 in (279 mm)[a]			
	Over surface		Through air		Over surface		Through air	
0 – 125	3/32	(2.4)[b]	3/32	(2.4)[b]	1/4	(6.4)[c]	1/8	(3.2)[c]
126 – 250	3/32	(2.4)	3/32	(2.4)	1/4	(6.4)[c]	1/4	(6.4)[c]
251 – 600	1/2	(12.7)[c]	3/8	(9.5)[c]	1/2	(12.7)[c]	3/8	(9.5)[c]

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

[b] For an appliance only employing motors rated 1/3 hp (249 W output) or less, these spacings may be not less than 1/16 in (1.6 mm).

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

24.4 A motor circuit may be judged under the requirements in 24.2 if the only motor load is a timer motor and if investigation of the motor circuit shows that such spacings are acceptable.

24.5 The spacing requirements specified in 24.3 do not necessarily apply to the inherent spacings of a component of the appliance, such as a snap switch. Such spacings shall comply with the requirements for the component in question if they are smaller than the values specified in Table 24.3.

24.6 At closed-in points, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of not less than 3/64 in (1.2 mm) is acceptable. Within a thermostat, other than at the contacts, the spacing between uninsulated live parts on opposite sides of the contacts may be not less than 1/32 in (0.8 mm) through air and 3/64 in (1.2 mm) over the surface of insulating material if the construction is such that the spacings will be maintained permanently.

24.7 Enameled wire is regarded as an uninsulated live part when spacings are being considered.

24.8 In applying 20.7, 35.1 and Table 24.3 to a motor not rated in horsepower, use is to be made of the applicable table of the National Electrical Code, ANSI/NFPA 70, that gives the relationships between horsepower and full-load currents for motors.

24.9 At terminal screws and studs to which connection may be made in the field by means of wire connectors, eyelets, and the like, as described in 11.1.2, the spacings shall not be less than those specified in Table 24.3 when the connectors, eyelets, or the like are in such position that minimum spacings – opposite polarity and to dead metal – exist.

24.10 An insulating liner or barrier of vulcanized fiber or similar material employed in lieu of spacings shall not be less than 1/32 in (0.8 mm) thick; and shall be located or of such material so that it will not be adversely affected by arcing.

Exception: Fiber not less than 1/64 in (0.44 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

24A Alternative Spacings – Clearances and Creepage Distances

24A.1 As an alternative to the spacing requirements specified in Spacings, Section 24, spacings shall be in accordance with the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, except:

a) Between field wiring terminals; and

b) Between uninsulated current-carrying parts and a metal enclosure.

24A.2 Appliances shall be considered Overvoltage Category 2 as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

24A.3 Printed wiring boards constructed of Type 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 Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fiber, and Materials Used in Printed Wiring Boards, UL 746E, shall be considered to have a minimum comparative tracking index of 100 as specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

24A.4 The internal microenvironment of the enclosure shall be considered Pollution Degree 2 as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, unless steps have been taken to achieve Pollution Degree 1 at a creepage distance by encapsulation or hermetic sealing. For printed wiring boards, coatings may be used to achieve Pollution Degree 1 provided that the coating satisfies the performance criteria specified in UL 840, and is used within the approved thickness.

24A.5 With respect to 24A.4, Pollution Degree 1 is considered an environment where no pollution or only dry, nonconductive pollution occurs. The pollution has no influence. Pollution Degree 2 is considered an environment where normally only nonconductive pollution occurs, except occasionally a temporary conductivity caused by condensation is to be expected.

24A.6 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 appliance. The appliance shall be evaluated for the rated impulse withstand voltage specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

24A.7 An overvoltage control having exposed low-voltage outputs shall be provided with a mechanism to indicate the malfunction of the overvoltage-protective control or system where the control outputs:

a) May be contacted during normal operation or user servicing; and

b) Have clearances between the low-voltage circuit and an overvoltage as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, and protected line-voltage circuits that have been evaluated in accordance with Clearance B requirements as specified in UL 840.

25 Grounding

25.1 In an appliance intended to be permanently connected to the power supply, all exposed dead metal parts that may become energized and all dead metal parts within the enclosure that are exposed to

contact during any user-servicing operation and that may become energized shall be conductively connected to:

a) The enclosure at the point of connection of the wiring system or the grounded wiring terminal or lead in accordance with the requirements in 25.8, and

b) The equipment-grounding terminal or lead. See 11.4.1 – 11.4.4.

25.2 A power-supply cord of an appliance rated a nominal 120 V and 15 A or less and intended for connection to a 2-wire circuit shall include an equipment-grounding conductor.

Exception: A portable appliance provided with a system of double insulation as mentioned in 25.4 is not required to comply with this requirement.

25.3 An equipment-grounding conductor of a flexible power-supply cord:

a) Shall be provided with insulation having an outer surface that is green with or without one or more yellow stripes,

b) Shall be connected to the grounding blade of an attachment plug of the grounding type, and

c) Shall be conductively connected to all exposed dead metal parts that may become energized and all dead metal parts within the enclosure that are exposed to contact during any servicing operation and that may become energized.

25.4 A portable, cord-connected appliance intended to be used on a circuit operating at not more than 150 V to ground may be provided with a system of double insulation in lieu of a means for grounding.

25.5 An appliance provided with a system of double insulation shall not be provided with a means for grounding.

25.6 A 2-wire appliance marked 120/240 V or otherwise marked to indicate that it is to be connected to a circuit operating at 150 V or less to ground may be double insulated.

25.7 If an appliance 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.

25.8 An appliance intended for use on a 120/208 or 120/240 V, 3-wire supply may be grounded by conductively connecting all exposed dead metal parts that may become energized and all dead metal parts within the enclosure that are exposed to contact during any user-servicing operation and that may become energized to the wiring terminal or lead intended for connection to a grounded supply conductor.

25.9 An appliance having a nominal rating of 120/208 or 120/240 V, 3-wire shall be equipped with a detachable link or the equivalent by which the dead metal parts may be connected to the grounded wiring terminal.

25.10 The link mentioned in 25.9 shall be located so that it will be readily visible at the terminals of the appliance after it has been installed as intended.

25.11 The connection between the grounding link mentioned in 25.9 and the grounded terminal shall not be made at the factory if the appliance is intended for use interchangeably, by alternation of the field connections, on either a 120-V, 2-wire circuit or on a 120/208 or 120/240-V, 3-wire circuit. In any other appliance rated 120/208 or 120/240-V, 3-wire, the connection between the grounding link and the grounded terminal shall be made at the factory. See 49.15.

PROTECTION AGAINST RISK OF INJURY TO PERSONS

26 Automatic Restarting of Motor

26.1 If an automatically reset protective device is employed in an appliance, automatic restarting of the motor shall not result in a risk of injury to persons.

26.2 The requirements in 26.1 necessitates the use of an interlock in the appliance if moving parts or the like may cause injury to persons upon automatic restarting of the motor.

27 Stability

27.1 Freestanding appliances

27.1.1 An appliance other than a fixed or wall-insert appliance shall be tested as described in 27.1.2. The appliance shall not overturn.

Exception: An appliance that is intended to be fastened to the floor need not be subjected to the tests in this section.

27.1.2 The empty appliance is to be placed on a flat surface inclined at an angle of 10 degrees from the horizontal. The loading door of the appliance is to be in the position most likely to cause the appliance to tip over. Casters, wheels, and other supporting means are to be positioned so as to result in the least stability. If adjustable feet are provided, they are to be adjusted to the same height.

27.2 Appliance stands

27.2.1 Hardware

27.2.1.1 An appliance stand shall contain all of the hardware needed to assemble the stand and to install the appliance on it.

Exception: A readily available part, such as a nail, a screw, or a piece of lumber, need not be provided if the instructions accompanying the kit include a description of the part and specify how the part is to be used.

27.2.2 Overturning

27.2.2.1 When installed as intended, the appliance shall be reliably attached to the stand assembly and shall not overturn when tested as described in 27.2.2.2 and 27.2.2.3.

27.2.2.2 An appliance/stand assembly that has been assembled as specified in the instructions is to be placed on a flat surface inclined at an angle of 10 degrees from the horizontal. The loading door of the appliance is to be in the position most likely to cause the appliance to tip over. If the stand permits stacking of appliances, the test is to be conducted both with and without the bottom appliance installed and with the door of the bottom appliance in the position that results in the most severe test. The appliance stand assembly is to be rotated on the inclined surface so that all positions are evaluated. The assembly is to be blocked to prevent sliding, and the appliances are to be loaded as described in 31.3 and 31.4, or unloaded, whichever results in the more severe test.

27.2.2.3 An appliance/stand assembly is to be assembled in accordance with the instructions. A fastener provided for anchoring the stand to a wall is not to be used if a tool is required to attach the appliance or the stand to the fastener or the fastener to the wall. The assembly is to be subjected to the tests specified

in (a) and (b). If the stand permits stacking of appliances, the tests are to be conducted both with and without the bottom appliance installed. The appliance or appliances are to be either loaded as described in 31.3, or unloaded, whichever results in the most severe test.

a) A 50-lb (22.6-kg) weight is to be suspended from the front of the upper appliance or from the front edge of the loading door. The weight and the loading door are to be positioned to produce the most severe loading condition. The weight is to remain suspended for 1 minute.

b) A hollow rubber ball 75 to 78 cm in circumference is to be filled with sand to a total weight of 20 lb (9.1 kg). The weight is to fall from rest as a pendulum through the distance necessary to strike with an impact of 30 ft•lbf (40.7 J). The ball is to strike the appliance-stand assembly 5 ft (1.5 m) above floor level or at the top of the upper appliance, whichever is less. All four sides of the appliance-stand assembly are to be subjected to the impact.

28 Sharp Edges, Projections, and Moving Parts

28.1 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to cause a risk of injury to persons in normal use and routine user-maintenance of the appliance.

28.2 A moving part, such as the rotor of a motor, a pulley, a belt, and a gear, shall be enclosed or guarded to reduce the risk of unintentional contact therewith by persons.

29 Parts Subject To Pressure

29.1 Pressure vessels

29.1.1 A pressure vessel having an inside diameter of more than 6 in (152 mm) and subject to a pressure of more than 15 psig (102 kPa) shall be marked with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) for a pressure not less than the greater of the following pressures:

a) The pressure corresponding to the maximum setting of a pressure-reducing valve provided as part of the assembly.

b) The marked maximum supply pressure from an external source.

c) The maximum allowable pressure setting of a required pressure-relief device.

d) 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 provided as part of the assembly.

e) The working pressure marked on the part.

Exception No. 1: A pressure vessel not covered by the inspection procedure of the ASME code, because of its application, shall comply with 29.2.1.

Exception No. 2: A section of a pressure system constructed of tubing is considered to comply with the requirements if the maximum pressure obtained during normal or abnormal operation is not greater than the values specified in Table 29.1 for a given diameter and thickness. The tubing is to be continuous or lengths of tubing are to be connected by hard-soldered, brazed, or welded joints.

Exception No. 3: A pressure vessel bearing the ASME code inspection symbol is considered to comply with the requirements if the vessel is marked with a working pressure not less than that to which it is subjected during normal or abnormal operation.

Table 29.1
Maximum pressure for tubing

Outside diameter,		Minimum wall thickness,		Maximum pressure to which tubing is subjected, psig (MPa)					
in	(mm)	in	(mm)	Seamless copper		Butt-welded steel		Seamless steel	
3/8	(9.5) or less	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)

29.2 Pressure relief devices

29.2.1 A part subject to periodic fluctuations in internal pressure, such as due to an external heat source, shall be provided with a pressure-relief device, such as a pressure-relief valve, a rupture member, a fusible plug, a soldered joint, nonmetallic tubing, or other equivalent pressure-relief means. A gasket shall not be used as the pressure-relief device.

29.2.2 A pressure vessel having an inside diameter greater than 3 in (76 mm) and subject to air or steam pressure generated or stored within the appliance, shall be protected by a pressure-relief device.

29.2.3 A shut-off valve shall not be located between the pressure-relief device and the protected part.

29.2.4 A gasket shall not be used as the pressure-relief device required by 29.2.1.

29.2.5 The maximum pressure setting of the pressure-relief device shall be less than the working pressure marked on the vessel.

29.2.6 A pressure-relief device shall:

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

b) Be installed so that it is readily accessible for inspection and repair, and

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

1) The risk of burn injury to persons is reduced, and

2) Operation of the device will not deposit moisture on uninsulated live parts, internal wiring, insulation or other parts that may be adversely affected by moisture.

29.2.7 A pressure-relief device having an adjustable setting is to be investigated on the basis of its maximum setting unless the adjusting means is sealed at a lower setting.

30 Contact with Rotating Tumbler

30.1 An appliance shall be provided:

a) With a means to prevent opening of the clothes loading-and-unloading door during the operating cycle; or

b) With an interlock that, when the clothes loading-and-unloading door is opened 3 in (76 mm) or more during the operating cycle, will:

1) Remove the driving force from the clothes basket, and

2) De-energize the heat source within 10 s.

30.2 The interlock mentioned in 30.1(b) shall prevent rotation of the basket and energizing of the heat source:

a) Until the door is closed to less than 3 in (76 mm) of opening and

b) Until a secondary-function control, manually operated from outside the appliance is actuated.

Exception: The requirement for a secondary-function control does not apply to an appliance having an opening into the clothes drum with a dimension of less than 8 in (203 mm) or a clothes drum with a volume less than 2 ft^3 (0.06 m^3).

30.3 The interlock required by 30.2 may allow momentary inching of the tumbler to facilitate loading and unloading.

30.4 To determine whether an appliance complies with requirements in 30.1 and 30.2, tests shall be conducted with the appliance operating under the normal load conditions specified in 31.3 and 31.4.

30.5 With reference to 30.1(a), a solenoid or similar component that is employed to hold the door latched in the closed position shall be subjected to a 6000-cycle endurance test consisting of energizing and de-energizing the component. There shall be no malfunction of the locking means or component as a result of this test.

30.6 If opening and closing the doors affects mechanical operation of the component, the test is to be conducted in the normal manner. The test is to be conducted at the rate of six times per minute unless a slower rate is dictated by design factors inherent in the appliance.

PERFORMANCE

31 General

31.1 The fabric used for tests is to be bleached, preshrunk cotton suiting, warp 55 threads per inch (25.4 mm) and filling 48 threads per inch. Individual cloths are to be 24 in (610 mm) by 36 in (915 mm), double hemmed to a size of 22 in (560 mm) by 34 in (865 mm). A small number of smaller cloths – 12 in (305 mm) by 12 in, double hemmed to a size of 10 in (255 mm) by 10 in – may be used if necessary to make the total weight of cloth correct.

31.2 Unless otherwise noted in the individual requirements, all tests are to be conducted with the appliance connected to a supply circuit of rated frequency, and having a potential of:

a) For an appliance rated from 110 V to 120 V, inclusive, 120 V;

b) For an appliance rated from 220 V to 240 V, inclusive, 240 V; and

c) For an appliance other than as mentioned in (a) or (b), the maximum rated voltage of the appliance.

31.3 The test load is to:

a) Consist of cloths as described in 31.1, and

b) Have a dry weight equal to the maximum load recommended by the manufacturer.

31.4 The test cloths are to be:

a) Soaked in water, which is to be extracted as it would be in normal use just before the cloths are placed in the appliance, or

b) Wet until they have absorbed a weight of water equal to the dry weight of the cloths.

32 Input Test

32.1 When operated as described in 32.2, the power input to an appliance shall not be more than 105 percent of the marked rating.

32.2 To determine whether an appliance complies with the requirements in 32.1, the appliance is to be connected to a supply circuit as described in 31.2. The appliance is to be loaded as described in 31.3 and 31.4. The power input to the appliance is to be measured with the appliance at normal operating temperatures.

33 Starting Current Test

33.1 When operated as described in 33.4, an appliance rated 15 A or less and intended for connection to a two-wire supply circuit shall start and operate normally without:

a) Tripping an overload protector provided as part of the appliance; or

b) Opening the fuse, when connected to a circuit protected by a 15-A fuse of other than the time-delay type.

Exception: A 15-A time-delay fuse may be employed provided the appliance is marked in accordance with 49.19.

33.2 When operated as described in 33.4, an appliance rated more than 15 A and intended for connection to a two-wire supply circuit, and an appliance intended for connection to a nominal 120/208 or 120/240 V, three-wire supply circuit shall start and operate normally without:

a) Tripping an overload protector provided as part of the appliance; or

b) Opening the fuse, when connected to a circuit protected by a fuse as described in 33.3.

33.3 The fuse mentioned in 33.2 is not to be a time-delay type. The current rating of the fuse is to be equal to the current rating of the supply circuit of the lowest rating to which the appliance can properly be connected, or, if the manufacturer recommends that the appliance be connected to a supply circuit of higher rating, the current rating of the fuse is to be equal to the current rating of the recommended supply circuit.

33.4 To determine whether an appliance complies with the requirements in 33.1 or 33.2, whichever applies, the appliance is to be connected to a supply circuit as described in 31.2. The circuit is to be protected by a fuse as specified in 33.1 or 33.3, whichever applies. The appliance is to be loaded as described in 31.3 and 31.4, and is to be at room temperature at the beginning of the test. The appliance is to be started three times. Each start of the appliance 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

appliance. The motor of the appliance is to be allowed to come to full speed after each start, and to come to rest between successive starts.

34 Insulation Resistance Test

34.1 An appliance employing insulating material that may be adversely affected by moisture under conditions of normal use shall be conditioned for 24 hours in moist air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (90 ±4°F). After the conditioning, the appliance shall have an insulation resistance of not less than 50,000 Ω between live parts and interconnected dead metal parts.

34.2 Ordinarily, insulation resistance is to be measured by means of a high-resistance voltmeter using a 250-V, direct-current circuit.

35 Dielectric Voltage Withstand Test

35.1 An appliance shall withstand for 1 minute without breakdown the application of a DC potential or a 60-Hz essentially sinusoidal potential between live parts and dead metal parts or between live parts of opposite polarity for a test on a capacitor as mentioned in (c). The test potential shall be:

a) 1000 V AC or 1400 V DC for an appliance employing a motor rated 1/2 hp (373 W) or less and 250 V or less. See 24.8.

b) 1000 V plus twice rated voltage or 1400 V DC plus 2.8 times rated voltage for an appliance employing a motor rated more than 1/2 hp or more than 250 V. See 24.8.

c) 1000 V AC, or 1000 V AC plus twice rated voltage – depending upon the value of the test potential applied to the appliance as a whole – for a radio-frequency-interference-elimination or arc-suppression capacitor.

35.2 To determine whether an appliance complies with the requirements in 35.1, the appliance is to be tested by means of a 500-VA or larger-capacity transformer the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached and is to be held at that level for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter. The appliance is to be at the maximum operating temperature reached in normal use.

36 Temperature Test

36.1 An appliance shall be tested as described in 36.4 – 36.11, and shall not:

a) Reach a temperature, at any point, high enough to cause a risk of fire or to damage any material used in the appliance, or

b) Exceed the temperature rises specified in Table 36.1.

Table 36.1
Maximum acceptable temperature rises

Materials and components			Degrees	
			C	F
1.	Varnished-cloth insulation		60	108
2.	Fuses			
	a.	Class G, J, L, T, and CC		
		Tube	100	180
		Ferrule or Blade	85	153
	b.	Others[f]	65	117
3.	Fiber employed as electrical insulation		65	117
4.	Wood or other combustible material, including the inside surfaces of the test enclosure and the surface supporting the appliance		65	117
5.	Class 105 insulation systems on coil windings of an a-c motor having a frame diameter of more than 7 in (178mm), of a d-c motor, and of a universal motor[a,b]:			
	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
6.	Phenolic composition employed as electrical insulation or as a part the deterioration of which could result in a risk of fire or electric shock[c]		125	225
7.	Insulated wire and cord[c]		35	63
8.	At any point within a terminal box or wiring compartment of a permanently connected appliance		35	63
9.	Capacitor:			
		Electrolytic[d]	40	72
		Other types[e]	65	117
10.	Class 105 insulation systems on coil windings of an a-c motor having a frame diameter of 7 in (178 mm) or less not including a universal motor[a,b]:			
	a.	In an open motor – thermocouple or resistance method	75	135
	b.	In a totally enclosed motor – thermocouple or resistance method	80	144
11.	Class 130 insulation system, other than as specified in 12 and 13[a]:			
		Thermocouple method	85	153
12.	Class 130 insulation systems on coil windings of an a-c motor having a frame diameter of more than 7 in (178 mm), of a d-c motor, and of a universal motor[a,b]			
	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
13.	Class 130 insulation systems on coil windings of an a-c motor having a frame diameter of 7 in (178 mm) or less, not including a universal motor[a,b]			
	a.	In an open motor or on vibrator coils:		

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and components	Degrees C	Degrees F
Thermocouple or resistance method	95	171
b. In a totally enclosed motor:		
Thermocouple or resistance method	100	180
14. Class 155 insulation systems on coil windings of an a-c motor having a frame diameter of 7 in (178 mm) or less, not including a universal motor[b]		
In an open motor:		
Thermocouple or resistance method	120	216

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

Item	Additional temperature rise	
Subitem a, item 5	15°C	(27°F)
Subitem a, item 10	5°C	(9°F)
Subitem a, item 12	20°C	(36°F)
Subitem a, item 13	10°C	(18°F)

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

[c] Phenolic composition and other insulation that has been investigated and found acceptable for use at higher temperatures may be used at those temperatures.

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

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

[f] These limitations do not apply to classes of fuses that have been investigated and found to be acceptable for use at higher temperatures.

36.2 A motor-protective device shall not operate during the temperature test described in 36.4 – 36.11.

36.3 A thermal- or overcurrent-protective device shall not open the circuit during the temperature test described in 36.4 – 36.11.

36.4 An appliance that has a single frequency rating, is to be tested at that frequency. An appliance rated 50 – 60 Hz is to be tested on 60-Hz alternating current.

36.5 All values for temperature rises in Table 36.1 are based on an assumed ambient temperature of 25°C (77°F); however, tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

36.6 A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minutes, indicate no change.

36.7 Ordinarily, coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting these devices – for example, a coil immersed in sealing compound – or unless the coil wrap includes thermal insulation, such as asbestos, or more than two layers – 1/32 in (0.8 mm) maximum – of cotton, paper, rayon, or the like. For a thermocouple-measured temperature of a coil of an alternating-current motor other than a universal motor (10 and 13 in Table 36.1) having a frame diameter (see note c of Table 36.1) of 7 in (178 mm) or less, the thermocouple is to be mounted on the integrally applied insulation of the conductor.

36.8 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2). However, it should be noted that when thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is common practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type indicating instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

36.9 A wall-insert or recessed appliance is to be mounted in an enclosure constructed of nominal 3/8-in-thick plywood painted black, and is to consist of a bottom, a back, two sides, and a top. However, the top is to be omitted for the test on a recessed appliance if its construction in such that a counter top could not be used. Each of these areas is to be brought into as intimate contact with the corresponding surface of the appliance as the configuration of the appliance will permit. Temperatures are to be measured at points on each of these enclosing surfaces.

36.10 For the temperature test, the drum of the appliance is to be normally loaded with cloths as described in 31.3 and 31.4 and at the beginning of each drying cycle, and operation is to be continued until temperatures have become constant. The interval between cycles is not to be longer than that necessary for removing the dried cloths from the drum and reloading it with damp cloths. If the appliance is provided with a heat-control switch or thermostat-adjustment means, the control is to be adjusted to give maximum temperatures.

36.11 An appliance other than a wall-insert or a recessed appliance is to be placed on a horizontal surface and is to be located in an alcove formed by three black-painted, vertical surfaces of nominal 3/8-in-thick plywood having a width and height so that they extend not less than 2 ft (610 mm) beyond the physical limits of the appliance in each of these directions. Unless specific clearances are recommended by the manufacturer, each of the surfaces is to be brought into as intimate contact with the corresponding surface of the appliance as the configuration of the latter permits.

36.12 An appliance is to be tested while connected to an exhaust system as described by the manufacturer. The exhaust duct is to be the same size as the exhaust-duct connection on the appliance. The duct is to consist of a center section approximately 11 ft long, a 90 degree elbow connected to each end of the center section, and an additional straight section, approximately 1.5 ft long, connected to each elbow. These dimensions may vary but the total length of the duct, not including elbows, is to be the maximum length recommended by the manufacturer or 14 ft (4.27 m), whichever is longer. One end of the exhaust duct is to be long enough to pass through the test enclosure and be connected to the appliance. A 0.3-in (7.6-mm) water column static pressure shall be applied to the outlet of this exhaust duct.

37 Abnormal Operation Test

37.1 An appliance shall be tested as described in 37.3 and 37.4, and there shall be no:

a) Emission of flame or molten metal;

b) Glowing or flaming of combustible material upon which the appliance may be place or that may be in proximity to the appliance as installed; or

c) Indication of flame or glowing embers in the load of cloths, either before or after the access door is opened.

37.2 With reference to 37.1(a), drops of melted solder are not considered to be molten metal.

37.3 With consideration given to the design of the appliance, the appliance is to be operated under abnormal conditions representing those likely to be encountered in actual service, such as the breakdown of drive belts or other parts, or interruption of the water supply to an appliance of the condensing type. Ordinarily, only one such condition is to be assumed at one time. In each abnormal-operation test, the drum is to be loaded as described in 31.3. The cloths are to be stacked by hand, without propping by

means of other objects, in the position that will result in maximum temperatures on the cloths in the stationary drum. Before the start of the test, the appliance is to be thoroughly heated by being operated through one complete cycle of normal operation.

37.4 The test is to be continued until ultimate results are observed; or, for an appliance controlled by a timer switch, the duration of the test is to be the maximum interval permitted by the timer. The appliance is to be installed as described in 36.9 or 36.11, whichever is applicable.

38 Automatic Temperature Control Test

38.1 An automatic temperature control shall be tested as described in 38.2 and 38.3, and temperature-regulating thermostat shall be tested as described in 38.2 and 38.5, and a temperature-limiting thermostat shall be tested as described in 38.2 and 38.6. As a result of these tests, there shall be no electrical or mechanical malfunction or breakdown of the temperature control, nor welding, or undue pitting or burning of the contacts. The fuse in the grounding connection shall not open.

38.2 During the tests described in 38.3 – 38.6, the enclosure of the appliance is to be connected to ground through a 3-A fuse.

38.3 An automatic temperature control is to be operated for 50 cycles with the appliance connected to a supply circuit having a voltage of 120 percent of the maximum rated voltage of the appliance.

38.4 For the test described in 38.3, connections are to be made so that there will be a difference of potential equal to the full test voltage between:

a) Live parts of the control mechanism, and

b) The enclosure and other dead metal parts of the appliance.

38.5 A temperature-regulating thermostat is to be operated for 100,000 cycles, making and breaking the load that it normally controls, with the appliance connected to a supply circuit having a voltage equal to the maximum rated voltage of the appliance.

38.6 An automatically reset temperature-limiting thermostat is to be operated for 100,000 cycles of making and breaking the load that it normally controls, with the appliance connected to a supply circuit having a voltage equal to the maximum rated voltage of the appliance. The test for a manually reset thermostat is to consist of 1000 cycles of operation under the normal-load conditions just described, plus 5,000 cycles of no-load operation.

39 Test for Switches

39.1 A switch or other device that controls a motor and that has not been investigated for the purpose for which it is used shall be tested as described in 39.2. As a result of the test, there shall be no electrical or mechanical malfunction or breakdown of the switch or other device, nor welding or undue pitting or burning of the contacts. The fuse in the grounding connection shall not open.

39.2 In a test to determine whether a switch or other control device complies with the requirement in 39.1, the appliance is to be connected to a grounded supply circuit of rated frequency and the voltage specified in 31.2. The rotor of the motor is to be locked. During the test, exposed dead metal parts of the appliance are to be connected to ground through a 3-A plug fuse, and the connection is to be such that any single-pole, current-rupturing device is in an ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, exposed dead metal parts of the appliance are to be connected so as to be positive with respect to a single-pole, current-rupturing device. The switch or other

device is to be operated for 50 cycles at a rate of not more than 10 cycles per minute; however, with the concurrence of those concerned, a faster rate of operation may be employed.

39.3 A switch or other device that controls a solenoid, a relay coil, or the like and that has not been investigated for the purpose for which it is used shall be tested as described in 39.4. As a result of the test, there shall be no electrical or mechanical malfunction or breakdown of the switch or other device nor welding or undue pitting or burning of the contacts. The fuse in the grounding connection shall not open.

39.4 In a test to determine whether a switch or other control device complies with the requirement in 39.3, the appliance is to be connected to a supply circuit of rated frequency and 110 percent of maximum rated voltage. The load on the device under test is to be the same as that which it is intended to control in normal service. The device is to be operated for 50 cycles at a rate of not more than 10 cycles per minute; however, with the concurrence of those concerned, a faster rate of operation may be employed.

40 Polymeric Materials Test

40.1 General

40.1.1 The requirements in 40.1 – 40.11 apply to polymeric materials, including thermoset materials, used as enclosures, functional parts, decorative parts, and liquid containers.

40.1.2 A test may be eliminated or modified if specimen testing, as part of another test program, indicates that the polymeric material is acceptable for the property being investigated.

40.1.3 A summary of the tests applicable to polymeric materials are identified in Table 40.1. The tests applicable to the particular polymeric part being evaluated are specified in Table 40.2.

Table 40.1
Polymeric materials test summary

Test No.	Test
1	Mold stress-relief distortion (7 h), 40.2.
2	Horizontal burning; HB, 40.3.
3	Flammability, 40.4.
4	Resistance to impact, 40.5.
5	Crushing resistance, 40.6.
6	Hot-wire ignition, 40.7.
7	Thermal aging, 40.8.
8	Volume resistivity, 40.9.
9	Enclosure flammability - large mass consideration, 40.10.
10	High current arc resistance to ignition, 40.11.

Table 40.2
Tests on a polymeric part

Group[a]	Description	Applicable test number[b]
1	A decorative part	2, 9[c,d]
2	A functional polymeric part subjected to a temperature of not more than 65°C (149°F) and not subjected to impact	1, 2, 9[c,d]
3	A functional polymeric part subjected to a temperature of not more than 65°C (149°F) and subjected to impact	1, 2, 4, 9[c,d]
4	A functional polymeric part subjected to a temperature of more than 65°C (149°F) and not subjected to impact	1, 2, 7[g], 9[c,d]
5	A functional polymeric part subjected to a temperature of more than 65°C (149°F) and subjected to impact	1, 2, 4, 7[g], 9[c,d]
6	A part serving as an enclosure or supplementary enclosure and subjected to a temperature of not more than 65°C (149°F)	1, 3[f], 4, 5[c], 6, 9[c,d]
7	A part serving as an enclosure or supplementary enclosure and subjected to a temperature of more than 65°C (149°F)	1, 3[f], 4, 5[c], 6, 7[g], 9[c,d]
8	A part spaced less than 12.7 mm (1/2 in) through air or over surface from an uninsulated current-carrying part	8, 10[f]
9	A part located in the air stream	2[h]

[a] If a polymeric part falls into more than one test group, separate samples shall be subjected to the tests required for each group.

[b] These requirements do not fully cover a plated plastic part if loss of bond strength between the plastic substrate and the metal coating can result in a reduction of electrical spacings, reduction in mechanical strength, or reduction in resistance to flammability. A plated plastic part shall be the subject of a separate investigation.

[c] These tests do not apply to an appliance readily movable from one place to another.

[d] This test shall be conducted only on an external part having a dimension greater than 1.83 m (6 ft) or a projected surface area greater than 0.93 m^2 (10 ft^2).

[e] An enclosure provided with a liner of vulcanized fibre, metal foil, or other material intended to reduce the flammability of the enclosure shall be tested with the liner in place and the flame shall be applied to the liner.

[f] Additional consideration shall be given to an appliance protected by an overcurrent device rated more than 30 A.

[g] Materials used within its temperature index based on historical data or a long term thermal aging program need not be subjected to Test No. 7.

[h] This test does not apply to a dryer drum seal or door gasket.

40.2 Mold stress-relief distortion test

40.2.1 A polymeric part is to be tested as specified in the Mold Stress-Relief Distortion Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. As a result of this test:

a) Spacings shall not be reduced to less than those specified in Table 24.1– Table 24.3;

b) Current-carrying parts or internal wiring shall not be exposed as determined in accordance with 8.1 – 8.8;

c) There shall be no damage that would increase the risk of fire, electric shock, or injury to persons; and

d) A part exposed to liquid shall not crack or leak.

Exception: This test may be waived if the part is required to be subjected to the Thermal-Aging Test, 40.8.

40.3 Horizontal burning test; HB

40.3.1 A polymeric part shall comply with the Horizontal Burning Test; HB in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The test specimens may be flat stock of the thickness of the end-use part or cut from the part.

40.4 Flammability test

40.4.1 Specimens of a polymeric part are to be subjected to the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and shall have a flammability rating of 5VA or 5VB.

Exception: Materials not classified 5VA or 5VB are to be tested in accordance with the 5-in (127-mm) flame test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C using parts molded from the polymeric material.

40.5 Resistance to impact test

40.5.1 A polymeric part is to be subjected to the impact test specified in 40.5.2. As a result of the impacts:

a) Spacings shall not be reduced to less than those specified in Table 24.1 – Table 24.3;

b) Current-carrying parts or internal wiring shall not be exposed as determined in accordance with 8.1 – 8.8; and

c) There shall be no damage that would increase the risk of fire, electric shock, or injury to persons.

40.5.2 Samples of the polymeric part shall be subjected to the Resistance to Impact Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Each sample is to be subjected to three impacts per surface at different points. The points chosen on the second and third samples are to be different from those chosen on the first sample.

40.5.3 Three samples are to be tested from each group as follows:

a) Group A is to be tested in as-received condition.

b) For Group B, the tests are to be performed on samples that have been subjected to Mold Stress-Relief Distortion, 40.2, and cooled to room temperature prior to the impact test.

c) For Group C, the tests are to be performed on samples that have been conditioned to the low temperature conditioning specified in UL 746C for indoor equipment. The samples are to be subjected to the impact while still cold.

Exception: If the size of the surface is such that the results of a second or third impact would be affected by previous impacts, only one impact is to be performed.

40.6 Crushing resistance test

40.6.1 Three complete as received samples of the polymeric enclosure shall comply with the Crushing Resistance Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

40.7 Hot-wire ignition test

40.7.1 A polymeric material shall have a performance level category (PLC) of 3 or less in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception: A polymeric material that complies with the Abnormal Overload Tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C is acceptable.

40.7.2 Bar specimens shall be subjected to the hot-wire-ignition test specified in the Standard for Polymeric Materials– Short Term Property Evaluations, UL 746A.

40.8 Thermal aging test

40.8.1 A polymeric part is to be tested as described in 40.8.2. As a result of the test:

a) Spacings shall not be reduced to less than those specified in Table 24.1 – Table 24.3;

b) Current-carrying parts or internal wiring shall not be exposed as determined in accordance with 8.1 – 8.8;

c) A condition shall not be produced that would increase the risk of fire, electric shock, or injury to persons; and

d) A part exposed to liquids shall not crack or leak.

40.8.2 Three complete samples of the polymeric part are to be placed in an oven for 1000 h at the temperature specified in Table 40.3. The parts are to be removed from the oven, cooled to room temperature, and examined for compliance with 40.8.1.

Table 40.3
Temperatures for oven conditioning

Maximum operating temperature of polymeric enclosure part, °C (°F)				Oven temperature,	
More than		Not more than		°C	(°F)
65	(149)	75	(167)	85	(185)
75	(167)	85	(185)	95	(203)
85	(185)	95	(203)	105	(221)
95	(203)	–	–	a	

[a] A polymeric part subjected to a temperature higher than 95°C (203°F) shall have a temperature index, based on historical data or a long-term thermal-aging program, that indicates its acceptability for use at the temperature involved. This part is to be the subject of a separate investigation.

40.9 Volume resistivity test

40.9.1 The resistance per unit volume (volume resistivity) of a polymeric material shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The volume resistivity is to be determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

40.10 Enclosure flammability test - large mass consideration

40.10.1 The flame-spread rating of a large mass polymeric enclosure part shall not exceed 200 when tested as described in the Standard for Test for Surface Burning Characteristics of Building Materials, UL

723 or the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

40.11 High current arc resistance to ignition test (HAI)

40.11.1 A polymeric material shall have a performance level category (PLC) of 2 or less in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: A polymeric material that complies with the End-Product Arc Resistance Test as specified in the requirements for High Current Arc Resistance to Ignition (HAI), UL 746C, are considered to comply with this requirement.

41 Overload Protection Test

41.1 An appliance having motor-overload protection in accordance with the requirement in 17.9(a) or 17.10(a) shall be tested as described in 41.3 and under the conditions specified in Table 41.1. A motor shall not exceed any of the temperatures specified in Table 41.1.

Table 41.1
Temperature limits for protected motors

Condition of operation	Motors with Class A insulation systems		Motors with Class B insulation systems	
Maximum constant running load on motor for which protector does not open the circuit	140°C	(284°F)	165°C	(329°F)
Locked rotor, during first hour	200°C	(392°F)	225°C	(437°F)
Locked rotor, after first hour:				
Peak	175°C	(347°F)	200°C	(392°F)
Average	150°C	(302°F)	175°C	(347°F)

41.2 The average temperature mentioned in Table 41.1 is to be determined by taking the arithmetic mean of:

a) The arithmetic mean of the maximum temperatures, and

b) The arithmetic mean of the minimum temperatures.

41.3 To determine if an appliance complies with the requirements in 41.1, temperatures during the locked-rotor test are to be measured by thermocouples on the surfaces of coils and parts other than commutators exposed on the interior of the motor. The test on a manually reset device is to be continued for four trips (three resets) with the device being reclosed as quickly as possible after it has opened. For an automatically reset device, the test is to be continued for 72 hours unless the appliance includes other controls, such as timer, that will positively and reliably limit the duration of the operation to a shorter interval.

41.4 An automatically reset motor-protective device incorporated in an appliance shall be tested as described in 41.5. As a result of the test, there shall be no permanent damage to the motor including excessive insulation deterioration. If the device permanently opens the circuit, it shall do so without grounding to the motor frame, damaging the motor, or a risk of fire.

41.5 An automatically reset motor-protective device is to be operated for 15 days unless it permanently opens the circuit in a shorter time, or unless the appliance includes other controls, such as a timer, that will positively and reliably limit the operation to a shorter interval. The rotor of the motor is to be locked, and

the motor is to be connected to a supply circuit having a voltage of 100 – 110 percent of the rated voltage of the motor.

41.6 A manually reset motor-protective device incorporated in an appliance shall interrupt for 50 operations the locked-rotor current of the motor for which it is designed without damage to itself.

41.7 When tested as described in 41.8 – 41.10, there shall be no ignition of cotton surrounding the outer enclosure of a motor-protective device, which might be the enclosure of the motor that it protects.

41.8 With reference to 41.7, three samples of a device controlling a 1/2-hp (373-W) or smaller motor are to be subjected to short circuits on a circuit limited to 200 A. For a device controlling a motor larger than 1/2-hp, three samples are to be subjected to short circuits on a circuit limited to 1000 A.

41.9 For the tests mentioned in 41.7 the power factor of the test circuit is to be 0.9 – 1.0, and the circuit capacity is to be measured without the device in the circuit.

41.10 A nonrenewable cartridge fuse is to be connected in series with the device under test. The fuse is to be the maximum current rating that will be accommodated by a fuseholder of the branch circuit to which the appliance normally would be connected. The test on one sample is to be made by closing the device on the short circuit.

41.11 A separate protective device incorporated in an appliance in accordance with the requirement in 17.10(d) shall be responsive to motor current and shall be rated or set in accordance with column A of Table 41.2.

Exception: If an overload relay selected in accordance with column A of Table 41.2 is not sufficient to start the motor or carry the load, a relay of the next higher size may be used, but the trip current shall not exceed the value specified in column B of Table 41.2.

Table 41.2
Maximum rating or setting of overcurrent protective device

Type of motor	Maximum ampere rating of device as a percentage of motor full-load current rating	
	A	B
Motor with marked service factor of 1.15 or more, or with marked temperature rise of 40°C or less[a]	125	140
Any other motor	115	130
[a] Motor manufacturer's applied marking.		

41.12 With reference to the requirements in 41.11, each winding connection of a multi-speed motor shall be considered separately.

42 Strain Relief Test

42.1 When tested as described in 42.2, a strain-relief device shall withstand for 1 minute, without displacement, a direct pull of 35 lbf (156 N) applied to the cord, with the connections within the appliance disconnected.

42.2 A 35-lb (16-kg) weight is to be suspended on the cord and supported by the appliance so that the strain-relief device will be stressed from any angle that the construction of the appliance permits. The

strain relief is not acceptable if there is movement of the cord, at the point of disconnection of the conductors, to indicate that stress would have resulted on the connections.

43 Permanence of Marking Test

43.1 A pressure-sensitive label or a label secured by cement or adhesive shall comply with the applicable requirements for indoor use labels exposed to high humidity and occasionally to water, specified in the Standard for Marking and Labeling Systems, UL 969.

43.2 If the labels are exposed to unusual conditions in service, such as fabric softeners and the like, three samples of the label applied to test surfaces as intended are to be conditioned for 24 h in a controlled atmosphere maintained at 23 ±2°C (73 ±4°F) and a relative humidity of 50 ±5 percent. The samples are then to be immersed for 48 hours in a solution representative of service and maintained at the temperature the solution would attain in service, but not less than 23 ±2°C (73 ±4°F). Following the immersion, the labels are to be investigated in the same manner as labels subjected to the water immersion test described in the Standard for Marking and Labeling Systems, UL 969.

44 Hydrostatic Pressure Test

44.1 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 for 1 min, without rupture, separation, or leakage, an internal hydrostatic pressure of five times the maximum pressures determined in accordance with 29.1.1.

44.2 The sample is to be filled with water so as to exclude air, and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value and is to be held at that value for 1 min. The results are not acceptable if the sample ruptures or leaks.

Exception No. 1: Leakage at a gasket is acceptable if it does not occur at a pressure lower than 40 percent of the required test value.

MANUFACTURING AND PRODUCTION TESTS

45 Grounding Continuity Test

45.1 Each appliance that has a power-supply cord having a grounding conductor 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 appliance that may become energized.

45.2 Any indicating device, such as an ohmmeter, a battery-and-buzzer combination, or the like, may be used to determine compliance with the requirement in 45.1.

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

46 Dielectric Voltage Withstand Test

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

a) Between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized; and

b) Between primary wiring and accessible low-voltage – 42.4 V peak or less – metal parts, including terminals.

46.2 The production-line test shall be in accordance with either condition A or condition B of Table 46.1.

Table 46.1
Production-line test conditions

Appliance rating, V	Condition A			Condition B		
	Potential, V		Time, s	Potential, V		Time, s
	AC	DC		AC	DC	
≤ 250	1000	1400	60	1200	1700	1
> 250 ≤ 600	1000+2V[a]	1400 + 2.8V[a]	60	1200+2.4V[a]	1700 + 3.4V[a]	1
[a] V = maximum marked voltage but not less than 240 V.						

46.3 The appliance may be in a heated or unheated condition for the test.

46.4 The test shall be conducted when the appliance is complete – fully assembled. It is not intended that the appliance be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover or a friction-fit knob, that would interfere with conducting the test need not be in place.

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

46.5 An appliance employing a solid-state component that may be damaged by the dielectric potential may be tested before the component is electrically connected provided a random sampling of production each day is tested at the potential specified in Table 46.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state-component damage while retaining representative-dielectric stress of the circuit.

46.6 The test equipment shall include a transformer having a DC or 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.

46.7 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.

46.8 If the output of the test equipment transformer is 500 VA or larger, the test potential may be indicated:

a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,

b) By a selector switch marked to indicate the test potential, or

c) In the case of equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential.

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

46.9 Test equipment other than that described in 46.6 – 46.8 may be used if found to accomplish the intended factory control.

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

Exception No. 1: An appliance – resistive, high-impedance winding, and 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.

Exception No. 2: The primary switch is not required to be in the on position if the testing means applies full test potential between primary wiring and dead metal parts with the switch not in the on position.

RATING

47 General

47.1 An appliance shall be rated in volts and in amperes; however, it may be rated in watts or kilowatts instead of amperes if the overall power factor is 80 percent or more. The number of phases shall be included in the ratings if the appliance is intended for connection to a polyphase circuit, and the ratings shall include the frequency – expressed in one of the following terms: hertz, Hz, cycles-per-second, cps, cycles/second, or c/s.

47.2 If an appliance includes an attachment-plug receptacle intended for use as a general-use outlet, the added load that the receptacle may impose on the appliance and its supply connections, but not less than 660 W or 6 A, shall be included in the electrical ratings of the appliance.

47.3 The rating of an appliance that is fastened or otherwise secured at a specific location and is intended to be connected to a supply circuit protected by a 15-A or a 20-A overcurrent-protective device shall not exceed 50 percent of the supply-circuit-current rating.

Exception: The rating may exceed 50 percent of the supply-circuit-current rating provided the appliance is marked in accordance with 49.13.

MARKING

48 General

48.1 Other than as noted in 48.2, cautionary marking that is required to be permanent shall be located on a part that:

a) Would require the use of a tool for removal,

b) Cannot be removed without impairing the operation of the appliance, or

c) Would not be removed during normal servicing of the appliance.

48.2 A cautionary marking may be located on a front-panel that is removed for normal servicing if tools are required for the panel's removal.

48.3 A marking that is required to be permanent shall be molded, die-stamped, paint-stenciled; stamped or etched metal that is permanently secured; or indelibly stamped on pressure sensitive labels, secured by adhesive, that comply with Permanence of Marking, Section 43. Ordinary usage, handling, storage, and the like of the appliance shall be considered in the determination of the permanence of the marking.

48.4 A cautionary marking intended to instruct the operator shall be legible and visible by the operator during normal operation of the appliance. A marking giving servicing instructions shall be legible and visible when such servicing is being performed.

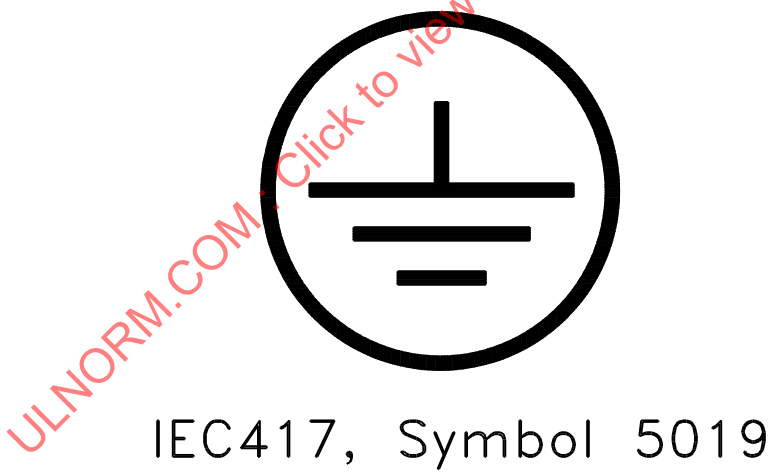
48.5 A cautionary marking shall be prefixed by the word "Caution," "Warning," or "Danger" in letters not less than 1/8 in (3.2 mm) high. The remaining letters of such marking shall not be less than 1/16 in (1.6 mm) high.

48.6 A marking on a readily removable part is not acceptable.

48.7 A pressure wire connector intended for connection of an equipment-grounding conductor shall be identified by being marked "G," "GR," "GND," "Ground," "Grounding," with the grounding symbol illustrated in Figure 48.1, a similar marking; or by a marking on the wiring diagram provided on the appliance.

Figure 48.1

Grounding Symbol



49 Details

49.1 An appliance and a field-attached accessory intended to be used with the appliance shall each have a permanent, legible marking that will be readily visible after the appliance has been installed as intended, without the necessity of moving the appliance, if of the wall-insert type; and that includes:

a) The manufacturer's name, tradename, trademark, or other descriptive marking by which the organization responsible for the product can be identified, hereinafter referred to as the manufacturer's name;

b) The catalog number or the equivalent; and

c) The electrical rating.

49.2 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, or other equivalent means of identification. The marking shall be of sufficient durability to withstand the environment involved.

Exception: An open-wire heating element need not be marked if it is part of an assembly that is marked to identify each element in the assembly with respect to the marking required by 49.2.

49.3 If a manufacturer produces or assembles appliances of a certain type at more than one factory, each finished appliance shall have a distinctive marking by which it may be identified as the product of a particular factory.

49.4 If an appliance employs a single motor as its only electric-energy-consuming component, the electrical ratings given on the motor nameplate need not be shown elsewhere on the appliance if this nameplate is readily visible after the motor has been installed in the appliance.

49.5 A permanently connected appliance 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 in accordance with 49.6; and

b) The maximum rating and type – for example, nontime-delay fuse or dual-element time-delay fuse – of supply-circuit overcurrent-protective device in accordance with 49.7.

49.6 With reference to the requirement in 49.5(a), the minimum supply-circuit conductor ampacity shall be based on the maximum input in accordance with 32.1.

49.7 With reference to the requirement in 49.5(b), the rating of the supply-circuit overcurrent-protective device shall not exceed the rating of the fuse employed in the short-circuit test of the motor overload-protective device employed in the appliance.

49.8 A cord-connected appliance shall be clearly and permanently marked, in a location that will be visible after the appliance has been installed as intended, with a statement indicating the size of the branch circuit to which the appliance is intended to be connected, and the maximum ampere rating of the overcurrent-protective device to be used in that branch circuit. See 33.3.

49.9 With reference to the requirement in 49.8, a marking on the back of the appliance is acceptable.

49.10 If an appliance employs a dual-voltage motor and if the motor nameplate is employed to give the electrical ratings of the appliance as mentioned in 49.4, the appliance shall also be marked to indicate the voltage for which it is connected when shipped from the factory.

49.11 If a cord-connected appliance employs a dual-voltage motor, instructions shall be provided to indicate the type of attachment plug that should be used if the appliance is reconnected for the alternate voltage.

49.12 An appliance 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 to which it should be connected. The marking shall be located so that it will be visible when power-supply connections to the appliance are being made.

49.13 An appliance that is fastened or otherwise secured at a specific location and is intended to be connected to a supply circuit protected by a 15-A or a 20-A overcurrent-protective device and that has a

current rating greater than 50 percent of the supply-circuit current rating shall be permanently marked to indicate that the appliance should be connected only to a supply circuit to which no other lighting units or general-purpose receptacles are connected. The marking shall be located so that it will be readily visible when connection to the supply circuit are made.

49.14 If a link as described in 25.9 is provided, instructions for the proper use of the link, which may be in the form of a circuit diagram, shall be provided on the appliance. If an appliance is for use either on a 120-V, 2-wire circuit or on a 120/240-V, 3-wire circuit, depending on the connections to be made when the appliance is installed, there shall be a warning marking on the appliance stating that dead metal parts are not to be connected to the grounded terminal when the appliance is used on the lower-voltage circuit.

49.15 An appliance intended for permanent connection to the power supply, and for which the connection between the grounding link and the grounded terminal is made at the factory in accordance with the requirements in 25.11 shall be legibly marked at a location visible during installation of the appliance with the word "WARNING" and the following or equivalent:

"Appliance grounded to neutral conductor through a link. If local codes do not permit grounding through the neutral, (1) disconnect the link from the neutral, (2) use grounding terminal or lead to ground appliance in accordance with local codes, and (3) connect neutral terminal or lead to branch-circuit neutral in usual manner (where the appliance is to be connected by means of a cord kit use 4-conductor cord for this purpose)."

This marking need not be permanent.

49.16 An appliance intended to be connected to the power supply by a flexible cord and attachment plug, and for which the connection between the grounding link and the grounding terminal is made at the factory in accordance with the requirements in 25.11, shall be legibly marked at a location visible during installation of the appliance with the word "WARNING" and the following or equivalent:

"Appliance grounded to neutral conductor through a link. Grounding through the neutral conductor is prohibited for new branch-circuit installations, or an area where local codes prohibit grounding through the neutral conductor. When installed where local codes do not permit grounding through the neutral conductor, the 3-conductor cord or cable assembly must be replaced by a 4-conductor cord or cable assembly. See manufacturer's instructions."

See 50.2.

49.17 An appliance provided with double insulation shall be permanently marked with the words "Double Insulation – When servicing, use only identical replacement parts." The words "double-insulated" may be used instead of "double insulation."

49.18 An appliance 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.

49.19 An appliance as mentioned in 33.1 that will not start and operate normally when connected to a circuit protected by a 15-A fuse of other than the time-delay type, but that will start and operate normally when connected to a circuit protected by a 15-A, time-delay fuse shall be plainly and permanently marked with the following or the equivalent: "Connect to a supply circuit protected by a 15- or 20-A circuit breaker or time-delay fuse."

49.20 If an appliance can be readily adapted upon installation for connection to a supply circuit of either of two different voltages, complete instructions, including identification of terminals, for making the connections for the different voltages shall be included in the permanent marking on the appliance.

49.21 An appliance shall be plainly and permanently marked with a warning that the appliance is intended for use only with fabrics that have been washed with water as a cleaning agent.

49.22 A warning shall be included in the permanent marking on an appliance consisting of the following:

a) For an appliance that includes a no-heat setting in its controls, "WARNING – To avoid fire hazard, do not use heat when drying articles containing foam rubber or similarly textured rubberlike materials" or the marking given in (b).

b) For any other appliance, "WARNING – To avoid fire hazard, do not dry articles containing foam rubber or similarly textured rubberlike materials."

Exception: Non-tumbling dryers are not required to have this marking.

49.23 An appliance that provides means for collection of dust and lint accumulation shall be plainly and permanently marked to indicate the necessity for keeping the lint trap cleaned out.

49.24 The markings required by 49.21 – 49.23 shall be separated from other markings to reduce the likelihood of their being overlooked.

49.25 An appliance shall be marked to indicate that it should be connected to an individual branch circuit.

49.26 It is recommended that an appliance be provided with a permanently attached schematic circuit diagram, secured to the back panel or at the location of the wiring terminals.

49.27 If an appliance as described in the Exception to 7.14 is not provided with a complete bottom enclosure, the appliance shall be marked to indicate that it should be vented to the outdoors.

49.28 An appliance shall be permanently marked:

a) At or near the exhaust opening of the appliance with the word "CAUTION" and the following statement or the equivalent: "Risk of Fire, A Clothes Dryer Produces Combustible Lint. Exhaust Outdoors. See Installation Instructions;" and

b) On a surface visible after installation of the appliance with the word "CAUTION" and the following statement or the equivalent: "Risk of Fire, A clothes Dryer Produces Combustible Lint. Exhaust Outdoors. Care Should Be Taken to Prevent the Accumulation of Lint Around the Exhaust Opening and in the Surrounding Area."

49.29 An appliance shall be provided with explicit instructions specifying:

a) How the appliance should be vented;

b) That the exhaust air should not be vented into a wall, a ceiling, or a concealed space of building;

c) That only rigid or flexible metal duct should be used for exhausting;

d) The maximum duct length and number of bends;

e) That the duct is not to be assembled with screws or other fastening means that extend into the duct and catch lint; and

f) That plastic ducting is not to be used.