UL 1204

STANDARD FOR SAFETY

Parts Cleaners

UL Standard for Safety for Parts Cleaners, UL 1204

First Edition, Dated July 19, 2018

Summary of Topics

This revision of ANSI/UL 1204 dated January 5, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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 requirements are substantially in accordance with Proposal(s) on this subject dated November 4, 2022.

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UL 1204

Standard for Parts Cleaners

First Edition

July 19, 2018

This ANSI/UL Standard for Safety consists of the First Edition including revisions through January 5, 2023.

The most recent designation of ANSI/UL 1204 as a Reaffirmed American National Standard (ANS) occurred on January 5, 2023. 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 parts cleaners used for cleaning or removing grease and similar substances from the item contaminated.

1.2 These requirements cover electrically operated parts cleaners rated up to 600 V, and manual type parts cleaners with no electrical connection.

1.3 These units are intended for use with flammable/combustible liquids or non-flammable/non-combustible cleaning solutions as detailed in the instruction manual provided with the unit and labels on the unit.

1.4 Requirements for the installation and use of parts cleaners are included in the National Electrical Code, NFPA 70, the Flammable and Combustible Liquids Code, NFPA 30, the Uniform Fire Code, NFPA 1, and the International Fire Code, IFC.

1.5 These requirements do not apply to the following:

a) Units intended to be installed outdoors;

b) Units intended for use with solvents or cleaning solutions that are considered unstable; or

c) Parts cleaners employing evaporating and condensing solvents.

1.6 These requirements do not address the physiological effects of solvents or cleaning solutions used with the equipment or any hazardous waste generated by the equipment.

2 Components

2.1 Except as indicated in 2.2, 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 used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

2.4 Specific components that are incomplete in construction features or restricted in performance capabilities may be employed if they 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.

3 Units of Measurement

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

4 Undated References

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

5 Glossary

5.1 For the purposes of this standard, the following definitions apply.

5.2 AUTO-IGNITION TEMPERATURE – The minimum temperature at which fuel-air mixtures will ignite spontaneously. This temperature is to be determined either at atmospheric pressure (14.7 psig), or at the maximum pressure present in the area of the fuel-air mixture, whichever is higher. At atmospheric pressure, the auto-ignition temperature of a solvent shall be determined in accordance with the Standard Test Method for Auto-Ignition Temperature of Liquid Chemicals, ASTM E 659.

5.3 COMBUSTIBLE LIQUID – A material that has a fluidity greater than 300 penetration asphalt when tested in accordance with the Standard Test Method for Penetration for Bituminous Materials, ASTM D 5, and that has a closed cup flash point at or above 37.8°C (100°F). Combustible liquids are subdivided as follows:

a) Class II liquids include those having flash points at or above 37.8°C and below 60°C (140°F);

b) Class IIIA liquids include those having flash points at or above 60°C and below 93°C (200°F); and

c) Class IIIB liquids include those having flash points at or above 93°C.

5.4 FLAMMABLE LIQUID – A material that has a fluidity greater than 300 penetration asphalt when tested in accordance with the Standard Test Method for Penetration for Bituminous Materials, ASTM D 5, and that has a closed cup flash point below 37.8°C (100°F) and a vapor pressure not exceeding 2068 mm Hg (40 psia). Flammable liquids are Class I liquids, and are subdivided as follows:

a) Class IA liquids include those having flash points below 22.8°C (73°F) and having a boiling point below 37.8°C (100°F);

b) Class IB liquids include those having flash points below 22.8°C (73°F) and having a boiling point at or above 37.8°C (100°F); and

c) Class IC liquids include those having flash points at or above 22.8°C (73°F) and below 37.8°C (100°F).

5.5 FLASH POINT – The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid within the vessel as specified by the appropriate test procedure and apparatus as follows:

a) The flash point of a liquid having a viscosity less than 45 Saybold Universal Seconds (SUS) at 37.8°C (100°F) and a flash point below 93°C (200°F) as determined in accordance with the Standard Test Method for Flash Point by Tag Closed Cup Tester, ANSI/ASTM D 56 Rev A.

b) The flash point of a liquid having a viscosity of 45 SUS or more at 37.8°C or a flash point of 93°C or higher as determined in accordance with the Standard Test Methods for Flash Point by the Pensky-Martens Closed Cup Tester – IP Designation: 34/99, ANSI/ASTM D 93 Rev A.

c) The Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus, ASTM D 3278, may be used for paints, enamels, lacquers, varnishes, and related units and their

components having flash points between 0°C (32°F) and 110°C (230°F) and having a viscosity lower than 150 centistokes at 25°C (77°F).

d) The Standard Test Methods for Flash Point by Small Scale Closed Tester – IP Designation: 303/83 (88), ANSI/ASTM D 3828, may be used for materials other than those for which specific setaflash methods exist.

5.6 IGNITABLE MIXTURE – A vapor-air, gas-air, dust-air mixture or combinations of these mixtures that can be ignited by a static spark.

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

5.8 LOW VOLAGE CIRCUIT – A circuit involving a potential of not more than 30 V (42.4 volts peak) and supplied by a primary battery, by a standard Class 2 transformer, or by an impedance which, as a unit, complies with all of the performance requirements for a Class 2 transformer.

5.9 LOWER FLAMMABILITY LIMIT (LFL) – The minimum concentration of vapor in air at which propagation of flame will occur in the presence of an ignition source. LFL is sometimes referred to as LEL, or lower explosive limit.

5.10 SOLUTION – a non-flammable/non-combustible cleaning liquid which has water as its primary content.

5.11 SOLVENT – A flammable or combustible liquid capable of dissolving another substance to form a uniformly dispersed mixture at the molecular or ionic level.

5.12 UNSTABLE LIQUID – A liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure, or temperature.

5.13 VESSEL – A container, tank, or other receptacle intended to contain solvent or other liquids.

CONSTRUCTION

6 General

6.1 Flammable/combustible liquids washers vats, lids, and supporting structures shall be constructed of steel, with a minimum thickness of 1.0 mm (0.04 in). The lid shall comply with the Lid Impact Test, Section 31.

6.2 Flammable/combustible liquids washers shall be provided with a fusible link assembly that will allow the lid to close in the event of a fire. See the Fusible Link Operation Test, Section 29.

6.3 Non-flammable/non-combustible cleaning solutions washers vats and lids may be constructed of a polymeric material or metal. The lid shall comply with the Lid Impact Test, Section 31.

6.4 Non-flammable/non-combustible cleaning solutions washers do not require a fusible link.

7 Solvents

7.1 The flammable/combustible solvents and non-flammable/non-combustible cleaning solutions intended for use with the equipment are to be described in the instruction manual.

7.2 Exemplar Safety Data Sheets (SDS) for the solvents and cleaning solutions intended for use with the equipment shall be supplied with the equipment.

8 Pumps

8.1 General

8.1.1 Submersible Pumps shall comply with 8.2 or 8.3.

8.1.2 Non-submersible electrical pumps motors shall be installed not less than 460 mm (18 inches) above floor level.

Exception: A motor evaluated for use in Class 1, Division 1, Hazardous Locations as defined in the National Electrical Code, NFPA 70, is not required to comply with this requirement.

8.2 Water based solution pumps

8.2.1 Pumps for use with water based solution shall be evaluated to the Standard for Motor-Operated Water Pumps, UL 778.

Exception: Pumps for use with water based solutions and complying with 8.3 are acceptable.

8.2.2 Pumps for use with water based solutions shall be permanently sealed.

8.3 Electric and pneumatic flammable and combustible liquid solvent pumps

8.3.1 Pumps for use with solvents other than water based shall be evaluated to the Standard for Power-Operated Pumps for Petroleum Dispensing Products, UL 79.

9 Supply Connections

9.1 General

9.1.1 Electrically powered parts cleaners shall be connected to a source of supply by either a power supply cord or a permanent connection.

9.1.2 Electrically powered parts cleaners connected by a supply cord shall comply with cord connected products, 9.2. Electrically powered parts cleaners that are permanently connected shall comply with permanently connected products, 9.3.

9.1.3 Electrically powered parts cleaners shall be provided with a connection to ground that complies with Grounding, Section 10.

9.2 Cord connected products

9.2.1 General

9.2.1.1 A cord connected unit shall be provided with a non-detachable cord and a grounding type attachment plug for connection to the supply circuit.

9.2.1.2 The power supply cord shall comply with the requirements of the Standard for Cord Sets and Power Supply Cords, UL 817.

9.2.1.3 The power supply cord shall be at least as serviceable as Type SJ cord and be evaluated for exposure to oil.

9.2.1.4 The power supply cord shall not be rated less than the rated voltage and current of the unit. In addition, the attachment plug shall be rated not less than 125 percent of the rated current of the unit.

9.2.1.5 The maximum length of the power supply cord from the face of the attachment plug to the plane or the connection point to the parts cleaner shall be 2.44 m (8 ft).

9.2.2 Strain relief

9.2.2.1 Strain relief shall be provided to reduce the risk of a mechanical stress on an attached power supply cord from being transmitted to terminals, splices, or interior wiring. See Strain Relief Test, Section 24. A knot in the flexible cord is not considered an acceptable form of strain relief.

9.2.2.2 Means shall be provided to restrict an attached power supply cord from being pushed into the enclosure of a unit through the cord entry hole if such displacement is likely to:

a) Subject the cord to mechanical damage;

b) Expose the cord to a temperature higher than that for which it is acceptable; or

c) Reduce spacings, such as to a metal strain relief clamp, below the minimum required values.

9.2.3 Bushings

9.2.3.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or similar device that shall be secured in place, and shall have a smooth, well-rounded surface against which the cord may bear. The heat and moisture resistant properties of the bushing material shall be such that the bushing is acceptable for the particular application.

9.2.3.2 If the cord hole is in porcelain, phenolic composition, or other nonconducting material, a smooth, well-rounded surface is considered to be equivalent to a bushing.

9.2.3.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushing, but rubber material (other than in a motor) is not acceptable. Vulcanized fiber may be used if the bushing is not less than 1.2 mm (3/64 inch) thick and if it is formed and secured in place so that it will not be affected adversely by moist conditions.

9.2.3.4 A separate soft rubber, neoprene, or polyvinyl chloride bushing may be used in the frame of a motor or in the enclosure of a capacitor physically attached to a motor – but not elsewhere in a unit, except as indicated in 9.2.3.5 – if the bushing is:

a) Not less than 1.2 mm (3/64 inch) thick, and

b) Located so that it will not be exposed to oil, grease, oily vapor, or other substances having a deleterious effect on the compound used.

9.2.3.5 A bushing of any of the materials mentioned in 9.2.3.4 may be used at any point in a unit if used with a type of cord for which an insulating bushing is not required, and if the edges of the hole in which the bushing is mounted are smooth and free from burrs and fins.

9.2.3.6 An insulated metal grommet is acceptable in place of an insulating bushing if the insulating material used is not less than 0.8 mm (1/32 inch) thick and completely fills the space between the grommet and the metal in which it is mounted.

9.3 Permanently connected products

9.3.1 General

9.3.1.1 A unit intended for fixed installation to the building or permanent connection electrically to the power supply shall have provision for connection of one of the wiring systems that, in accordance with the National Electrical Code, NFPA 70, would be acceptable for the unit.

9.3.1.2 The location of a terminal box or compartment, where power supply connections are to be made to a unit intended to be permanently connected, shall be constructed so that these connections may be readily inspected after the unit is installed as intended.

9.3.1.3 A terminal compartment intended for the connection of a supply raceway shall be attached to the unit so that it will not turn with respect to the unit.

9.3.1.4 An electrical component shall not be mounted on a part, such as the cover of a wiring terminal compartment, which must be removed for the purpose of making or inspecting field wiring connections.

Exception: A single electrical component, such as a switch, a pilot light, or a similar device, may be mounted on a wiring compartment cover when:

a) The component connecting leads are of a length that provides for the making and examination of field-wiring connections;

b) None of the component connections are to be field wired;

c) Strain relief is provided to prevent stress from being transmitted to the component wiring terminations and complies with the strain relief test described in Section 24;

d) The minimum size of the component leads is 18 AWG (0.82 mm^2); and

e) Wiring termination on the component are recessed or protected by barriers of insulating or similar material that will provide protection from contact with siring installed in the box, or unintentional contact during installation or inspection of field wiring.

9.3.2 Wiring terminals

9.3.2.1 A unit intended for permanent connection to the power supply shall be provided with wiring terminals or leads for the connection of conductors having an ampacity of not less than 125 percent of the current rating of the unit when the load is continuous (3 hours or more) and not less than the current rating of the unit when the load will be intermittent.

9.3.2.2 For the purpose of these requirements, wiring terminals are terminals to which power supply or control connections will be made in the field when the unit is installed. It is to be assumed that 60°C (140°F) wire will be used for connections to a continuous load type of unit rated at 80 A or less and an intermittent load type of unit rated at 100 A or less. Wire rated for 75°C (167°F) will be assumed to be used with units rated in excess of these values.

9.3.2.3 A wiring terminal shall be provided with a soldering lug or a pressure wire connector securely fastened in place; for example bolted or held by a screw, except that a wire binding screw may be used 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.

9.3.2.4 A wiring terminal shall not turn or shift in position. Friction between surfaces is not an acceptable means to prevent turning or shifting. Examples of acceptable means are:

a) The use of two screws or rivets;

b) Square shoulders or mortises;

c) A dowel pin, lug, or offset; or

d) A connecting strap or clip fitted into an adjacent part.

9.3.2.5 A wire binding screw at a wiring terminal shall not be smaller than No. 10, except that a No. 8 screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) or smaller conductor. A No. 6 screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm^2) control circuit conductor.

9.3.2.6 A terminal plate tapped for a wire binding screw shall be of metal not less than 1.3 mm (0.050 inch) thick, except that a plate not less than 0.8 mm (0.030 inch) thick complies when the tapped threads have mechanical strength that has been determined acceptable. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

9.3.2.7 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 9.3.2.1, but not smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

9.3.2.8 A wire binding screw shall thread into metal.

9.3.2.9 A unit intended for connection to a grounded power supply conductor shall have one terminal or lead identified for connection of the grounded conductor of the supply circuit when it uses:

a) A lampholder or element holder of the Edison screw shell type;

b) A single pole switch; or

c) A single pole automatic control.

The identified terminal or lead shall be the one that is connected to screw shells of lampholders or element holders. There shall be no connection to single pole switches or single pole automatic controls.

9.3.2.10 Except as noted in 9.3.2.11, the free length of a lead inside an outlet box or wiring compartment shall be 152 mm (6 inches) or more if the lead is intended for field connection to an external circuit.

9.3.2.11 A lead may be less than 152 mm (6 inches) in length when it is evident that the use of a longer lead might result in a risk of fire or electric shock, and that the intended connection to the lead is practical.

10 Grounding

10.1 General

10.1.1 Parts cleaners shall be provided with a means for grounding. All exposed dead metal parts and all dead metal parts within the enclosure that are exposed to contact during any servicing operation and that are likely to become energized shall be connected to the means for grounding.

10.1.2 With reference to 10.1.1, the following dead metal parts are not considered likely to become energized:

a) A small metal part such as an adhesive attached foil marking, a screw, a handle, and the like, that is:

1) On the exterior of the enclosure and separated from all electrical components by grounded metal; or

2) Electrically isolated from all electrical components.

b) A panel or cover that is isolated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture resistant insulating material not less than 0.8 mm (1/32 inch) thick that is secured in place.

c) A panel or cover that does not enclose uninsulated live parts and is electrically isolated from other electrical components.

d) Cores and assembly screws of relays, solenoids, and the like.

10.1.3 The following are acceptable means for grounding:

a) A knockout or equivalent opening in the metal enclosure of equipment intended to be permanently connected by a metal enclosed wiring system;

b) An equipment grounding terminal or lead in equipment intended to be permanently connected by a nonmetal enclosed wiring system (for example, nonmetallic sheathed cable); or

c) An equipment grounding conductor in the cord of cord connected equipment.

10.1.4 The grounding conductor of a supply circuit cord shall be secured to the frame or the enclosure of the equipment by means of a screw or equivalent means that is not to be removed during servicing for purposes other than servicing the cord. Solder alone shall not be used for securing the grounding conductor.

Exception: A quick connect that complies with the requirements in the Standard for Electrical Quick Connect Terminals, UL 310, can be used as equivalent means as referenced in 10.1.4.

10.1.5 The grounding conductor of cord connected equipment shall be connected to the grounding member of an attachment plug. The grounding member shall be fixed.

10.1.6 The attachment plug shall be constructed such that upon separating the plug from the receptacle the ground connection will break last after the supply conductors.

10.1.7 The principal equipment grounding conductor, or path, shall not include a trace of a printed wiring board.

10.2 Grounding identification

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

10.2.2 A wire binding screw intended for the connection of an equipment grounding conductor shall have a green colored head that is hexagonal shaped, slotted, or both.

10.2.3 A terminal provided for the connection of a grounded circuit conductor shall be made of or plated with a metal white in color, or have the word "white" located adjacent to the terminal and shall be readily distinguishable from the other terminals. Or, proper identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded circuit conductor shall be finished to show a white or natural gray color and shall be distinguishable from the other leads.

10.2.4 Any connection intended for connection of an equipment grounding conductor shall be plainly identified, such as by being marked "G", "GR", "GROUND", "GROUNDING", or with the symbol (IEC 60417, symbol No. 5019) or the like, or by a marking on a wiring diagram provided on the equipment.

10.2.5 A terminal intended solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the size acceptable for the particular unit, in accordance with Table 10.1.

Table 10.1
Bonding wire conductor size

Maximum rating or setting of automatic overcurrent device in circuit ahead of equipment, amperes	Minimum size of copper conductor,		Minimum size of aluminum conductor,	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	4	(21.2)

10.3 Grounding circuit resistance

10.3.1 The resistance between the point of connection of the equipment grounding means, at or within the equipment, and any other point in the grounding circuit shall not be more than 0.1 ohm when measured as prescribed in Grounding Circuit Resistance Test, Section 21.

11 Spacings

11.1 Line voltage circuits

11.1.1 The spacings in a unit shall be in accordance with Table 11.1.

Table 11.1
Minimum spacings

Parts involved	Potential involved in volts	Through air		Over surface	
		inch	(mm)	inch	(mm)
Between live parts of opposite polarity and between a live part and a dead metal part, other than the enclosure, which may be grounded.	0 – 250	1/4	(6.4)	3/8	(9.5)
	251 – 600	3/8	(9.5)	1/2	(12.7)
Between alive part and the enclosure.	0 – 600	1/2	(12.7)	1/2	(12.7)

NOTES

1 These spacings do not apply to connecting straps or busses extending away from wiring terminals.

2 Applies to the sum of the spacing involved where an isolated dead part is interposed.

3 A spacing of not less than 3/8 inch (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.

11.1.2 An insulating liner or barrier of fiber or similar material used where spacings would otherwise not comply shall not be less than 0.8 mm (1/32 inch) thick and shall be located or constructed of a material so that it cannot be affected by arcing, except that fiber not less than 0.4 mm (1/64 inch) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

11.1.3 Unless protected from mechanical abuse during assembly and intended functioning of a unit, a barrier of mica shall have a minimum thickness of 0.25 mm (0.010 inch).

11.2 Low voltage circuits

11.2.1 The spacings in a low voltage limiting control shall comply with the requirements in 11.1.1 – 11.1.3 and Table 11.1.

11.2.2 The spacing between uninsulated live parts of opposite polarity and between those parts and dead metal that may be grounded in service is not specified for parts of circuits that are classified as low voltage in 5.8.

PROTECTION AGAINST INJURY TO PERSONS

12 Strength of Materials

12.1 Materials used in the construction of the unit that reduce the risk of injury to persons shall be determined to be acceptable for the particular use.

12.2 The frame and enclosure of a unit shall be strong and rigid to resist the abuses to be encountered during intended use. The degree of resistance inherent in the unit shall preclude total and partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects which alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

12.3 In regard to 12.2, the unit shall comply with the Lid Impact Test, Section 31.

12.4 Instruction shall be furnished to address installation in high traffic areas with regard to mitigation of puncture due to collision.

13 Sharp Edges

13.1 An enclosure, a frame, a guard, a handle, or the like shall not be sufficiently sharp to constitute a risk of injury to persons in normal maintenance and use.

13.2 Whenever referee measurements are necessary to determine that a part is not sufficiently sharp to constitute a risk of injury to persons in accordance with 13.1, the method described in the requirements for determination in the Standard for Test for Sharpness of Edges on Equipment, UL 1439, is to be employed.

14 Stability

14.1 A parts cleaner shall not be able to overturn and result in a risk of injury to persons.

14.2 In accordance with 14.1, parts cleaners shall be subjected to the Stability Test, Section 26.

15 Strength of Handles

15.1 If a product is provided with handles that are intended to be used to lift or carry the product, the handles shall be subjected to the Strength of Handles Test, Section 32.

PERFORMANCE

16 General

16.1 Complete samples of parts cleaner units are to be subjected to the following tests. Unless noted otherwise, samples are to be installed and operated in accordance with the instruction manual. Any accessories or ancillary devices recommended for use with the unit shall be utilized as intended.

16.2 Unless otherwise noted, samples are to be operated with the solvents recommended in the instruction manual. Solvents used during the following tests are to be selected to reflect the most stringent application of the test requirements.

16.3 A single model, or selected representative models, may be tested to represent a series of similar units. Samples are to be selected to represent all of the construction and performance features provided in the series.

16.4 The manufacturer is to provide the solvents to be used for testing, and to retrieve or otherwise dispose of the solvents and hazardous wastes after the investigation is completed.

16.5 When the recommended ambient temperature by the manufacturer is at or below 40°C (104°F) then testing may be performed at 25°C (77°F). If the ambient temperature exceeds 40°C, testing is also to be conducted at the maximum ambient temperature recommended by the manufacturer if it is determined that it may affect the results of the tests. The affect of the elevated ambient temperature on the LFL measurements is to be examined.

17 Input Test

17.1 The power input, current or wattage, shall not be more than 110 percent of its marked rating.

17.2 To determine whether a unit complies with the requirement in 17.1, the power input is to be measured with the unit at normal operating temperature under full-load conditions and while connected to a supply circuit adjusted to be the highest of the following:

a) The marked voltage rating; or

b) The highest voltage within the range of voltages marked on the product.

18 Starting Current Test

18.1 A product shall start and operate as intended on a branch circuit protected by a fuse – not time delay – having a current rating corresponding to the product. The performance is unacceptable if the fuse opens or an overload protector provided as part of the product trips.

Exception: A time delay fuse may be employed if the product is marked in accordance with 36.13.

18.2 In a test to determine whether a product complies with the requirement in 18.1, the product is to be started three times. The product is to be at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation and the motor is to be allowed to come to rest between successive starts.

19 Leakage Current Test

19.1 The leakage current of a cord connected product rated 250 V or less, when tested in accordance with 19.3 – 19.10, shall not be more than:

a) 0.5 mA for a grounded (3-wire) portable product; and

b) 0.75 mA for a grounded (3-wire) stationary or fixed product.

19.2 Leakage current refers to all currents, including capacitively coupled currents, which may be conveyed between exposed conductive surfaces of a product and ground or other exposed conductive surfaces of a product.

19.3 All exposed conductive surfaces are to be tested for leakage currents. If simultaneously accessible, the leakage currents from exposed conductive surfaces are to be measured to the grounded supply conductor individually as well as collectively, and from one surface to another. A part is considered to be an exposed surface unless guarded by an enclosure. Surfaces are considered to be simultaneously accessible when they can be readily contacted by on or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that do not present a risk of electric shock.

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

19.5 The measurement circuit for leakage current is to be as illustrated in Figure 19.1. The measurement instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

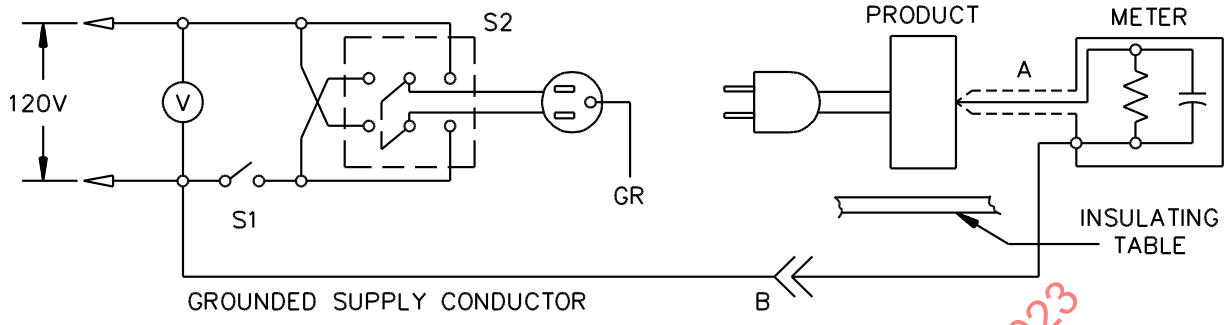
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarads.

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

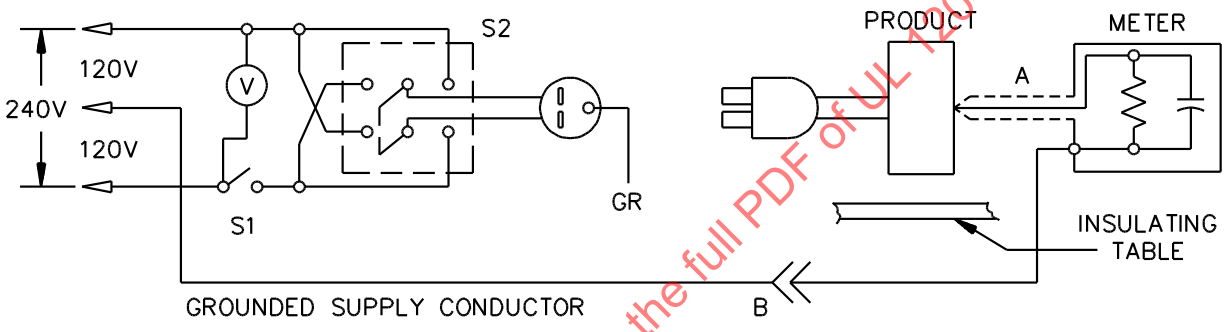
c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response – ratio of indicated to actual value of current – that is equal to the ratio of the impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75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

Figure 19.1

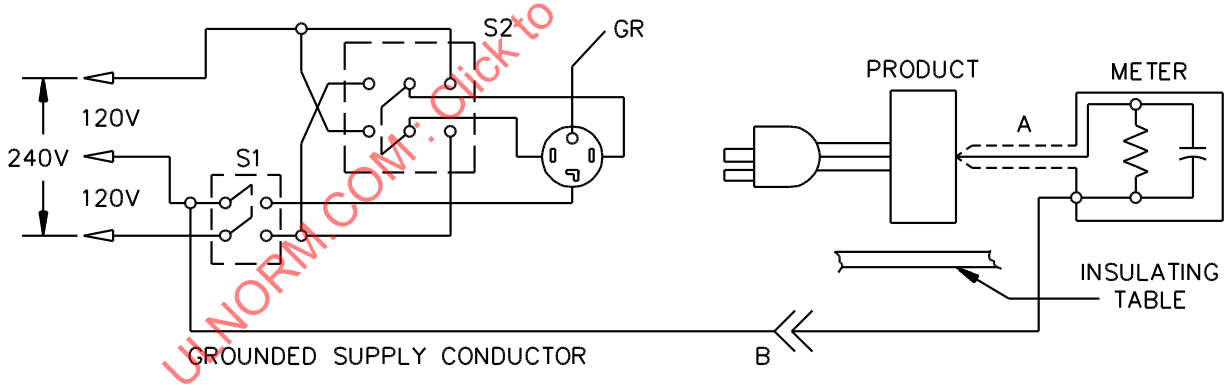
Leakage current measurement circuits



A – Refrigerator intended for connection to a 120 volt power supply.



B – 240 or 208 volt 2-wire refrigerator intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



C – 240 or 208 volt 3-wire refrigerator intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

LC300L

19.6 The meter is to be connected to the accessible part and the grounded supply conductor unless the meter is being used to measure leakage between two parts of a product.

19.7 A sample product is to be prepared for leakage current measurement as follows:

a) The sample is to be representative of the wiring methods, routing, components, component location and installation, and the like, of a production unit;

b) The grounding conductor is to be open at the attachment plug and the sample is to be isolated from ground;

c) The sample is to be tested in the as-received condition;

d) The test is to be conducted at ambient temperature and humidity; and

e) The supply voltage is to be adjusted to rated voltage.

19.8 The test sample is to be arranged so that all parallel ground paths are eliminated.

19.9 The leakage current sequence, with reference to the measuring circuit, Figure 19.1, is to be as follows:

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

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

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

19.10 A product shall also comply with the leakage current measurements following exposure for 48 hours to moist air having a relative humidity of 88 ±2 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). The product is to be tested as follows:

a) The product is to be at a temperature just above the test chamber temperature when it is placed in the humidity chamber.

b) The product is to remain in the humidity chamber for 48 hours.

c) Following this exposure, while still in the test chamber, the sample is to be tested unenergized as indicated in 19.9(a).

d) The sample is then to be removed from the test chamber and tested while energized as indicated in 19.9 (b) and (c), until the leakage current has stabilized or decreased.

20 Temperature Test

20.1 A unit, when tested under the conditions described in 20.2 – 20.20, shall comply with all of the following conditions:

a) The unit shall not attain at any point a temperature that would constitute a risk of fire or damage to any materials used in the unit.

b) At any time during the test, temperature rises at specific points shall not be greater than indicated in Table 20.1 and Table 20.2.

c) The unit shall comply with the requirement in 12.2.

d) The maximum surface temperature that can be exposed to flammable or combustible liquids, or ignitable mixtures, shall not be within 10°C (18°F) of the auto-ignition temperature of any of the solvents investigated for use with the unit.

Table 20.1
Maximum temperature rises

Materials and component parts	°C	(°F)
1. Any point within a terminal box or wiring compartment of a permanently connected unit in which field-installed conductors are to be connected (including such conductors themselves) unless the unit is marked in accordance with 36.8.	35	(63)
2. Any point on a surface adjacent to a unit that is:		
a) Permanently connected electrically or	65	(117)
b) Cord-connected and intended to be fastened in place or located in a dedicated space – including the surface on which the unit is mounted, and specified points on test surfaces and enclosures at designated clearances from the unit.	65	(117)
3. Fuses	65	(117)
4. Fiber used as electrical insulation or as cord bushings	65	(117)
5. Wood or other combustible material that is part of a unit	65	(117)
6. Cotton or rayon braid of flexible cord	65[a]	(117)[a]
7. Class 105 insulation systems on winding relays or solenoids and the like:		
Thermocouple method	65	(117)
Resistance method	85	(153)
8. Class A insulation systems on coil winding of a-c motors having a frame diameter of more than 7 inches (178 mm) and of d-c and universal motors[b,c]:		
A. In open motors:		
Thermocouple method	65	(117)
Resistance method	75	(135)
B. In totally enclosed motors:		
Thermocouple method	70	(126)
Resistance method	80	(144)
9. Class A Insulation systems on coil windings of a-c motors (not including universal motors) having a frame diameter of 7 inches (178 mm) or less and on vibrator coils – thermocouple or resistance method[b,c]:		
A. In open motors and on vibrator coils	75	(135)
B. In totally enclosed motors	80	(144)
10. Class 130 insulation systems on winding of relays, solenoids and the like:		
Thermocouple method[b]	85	(153)
Resistance method	105	(189)
11. Class B insulation systems on coil windings of a-c motors having a frame diameter of more than 7 inches (178 mm) and of d-c and universal motors[b,c]:		
A. In open motors:		
Thermocouple method	85	(153)

Table 20.1 Continued on Next Page

Table 20.1 Continued

Materials and component parts	°C	(°F)
Resistance method	95	(171)
B. In totally enclosed motors:		
Thermocouple method	90	(162)
Resistance method	100	(180)
12. Class B insulation systems on coil windings of a-c motors (not including universal motors) having a frame diameter of 7 inches (178 mm) or less and on vibrator coils – thermocouple or resistance method[b,c]:		
A. In open motors and on vibrator coils	95	(171)
B. In totally enclosed motors	100	(180)
13. Phenolic composition used as electrical insulation or where deterioration would result in risk of fire, electric shock, or injury to persons[d]	125	(225)
14. Points on surface supporting a cord-connected heater	125	(225)
15. Unit plug	175	(315)
16. Insulated wire or cord	25°C less than its temperature rating[e]	(45°F less than its temperature rating)[e]
17. Sealing compound	See footnote f	See footnote f
18. Copper conductors, bare or insulated, without a nickel coating or other protection	125	(225)
19. Termination of copper conductor and pressure terminal connector without being nickel coated or otherwise protected	125	(225)

[a] Inside a unit, the braid of a heater cord may be subjected to a greater rise if the insulation is held in place by other appropriate means.

[b] See 20.9 and 20.10.

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

[d] The limitation on phenolic composition does not apply to a compound that has been investigated and determined to have special heat-resistant properties.

[e] Inside a unit, the temperature rise on a wire or cord may be greater than the specified maximum rise, provided that the insulation on each individual conductor is protected by supplementary insulation (such as braid, wrap, tape, or close-fitting tubing) that is appropriate for the temperature and the type of insulation involved.

[f] Unless a thermosetting material, the maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (59°F) less than the softening point of the compound as determined by the Standard Test Method for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus, ASTM E 28.

Table 20.2
Maximum surface temperatures

Location	Composition of surface,[a]	
	Metal	Nonmetallic
Handles or knobs that are grasped for lifting, carrying or holding	50°C (122°F)	60°C (140°F)
Handles or knobs that are contacted but do not involve lifting, carrying, or holding; and other surfaces subject to contact and user maintenance	60°C (140°F)	85°C (185°F)
Surfaces other than a heating function surface and known to be hot due to proximity to the heating function surface[b]	70°C (158°F)	95°C (203°F)

NOTE – If the test is conducted at a room temperature of other than 25°C (77°F), the results are to be corrected to that temperature.

[a] A handle, knob, or the like, made of a material other than metal, that is plated or clad with metal having a thickness of 0.005 inch (0.13 mm) or less is considered to be, and is evaluated as, a nonmetallic part.

[b] Unless labeled “HOT” in accordance with 36.10.

20.2 All values in Table 20.1 are based on an assumed room ambient temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of an automatic thermal control during the test limits the temperatures under observation, no temperature higher than 25°C plus the specified maximum rise is acceptable.

20.3 The unit is to be operated continuously. Operation is to continue until maximum temperatures are reached.

20.4 If the unit is capable of being operated without solvent, the unit is to be operated dry until maximum temperatures are obtained.

20.5 Adjustable temperature controls, if provided and can be adjusted by the end user, are to be adjusted to their maximum settings.

20.6 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2), except that a coil temperature may be determined by the change-of-resistance method if the coil is inaccessible for mounting thermocouples. When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer type instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

20.7 For tests that are to be continued until constant temperatures are attained, thermal equilibrium is to be considered to exist only if three successive readings indicate no change when taken at the conclusion of each of three consecutive equal intervals of time, the duration of each interval being whichever of the following is longer:

a) 5 minutes; or

b) 10 percent of the total test time elapsed previous to the start of the first interval.

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

20.9 The temperature of a coil or winding is to be measured by means of thermocouples mounted on the outside of the coil wrap. If the coil wrap is inaccessible for mounting thermocouples, for example, a coil immersed in sealing compound, or if the coil wrap includes thermal insulation, or more than 0.8 mm (1/32 inch) of cotton, paper, rayon, or similar insulation, the change-of-resistance method is to be used. For the thermocouple measured temperature of a coil of an alternating current motor, other than a universal motor having a frame diameter of 178 mm (7 inches) or less (items 9 and 12 in Table 20.1), the thermocouple is to be mounted on the integrally applied insulation of the conductor.

20.10 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may exceed the maximum temperature specified in Table 20.1 by the amount specified in Table 20.3. However, the temperature rise measured by the change-of-resistance method shall not exceed the values indicated in Table 20.1.

Table 20.3
Additional thermocouple rise

Item in Table 20.1	Temperature rise, °C	(°F)
Item 7 and part A of item 8	15	(27)
part A of item 9	5	(9)
part A of item 11	20	(36)
part A of item 12	10	(18)

20.11 If the coil wrap does not exceed its temperature limitation by radiation from an external source, the temperature of the coil may be measured by means of a thermocouple on the integral insulation of the coil conductors.

20.12 To determine whether a unit complies with the requirements in 20.1, the unit is to be operated continuously until constant temperatures have been reached. The test voltage is to be the highest of the following:

a) The marked voltage rating; or

b) The highest voltage within the range of voltages marked on the product.

20.13 If a unit uses a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be the test voltage specified in 20.12. A motor supplied from a separate circuit is to be connected to a test voltage derived from its marked rated voltage in accordance with 20.12.

20.14 In conducting a test to determine whether a unit complies with the temperature requirements, it is to be mounted or supported as in service and tested under conditions approximating those of normal operation, except as otherwise noted. Temperatures are to be observed on nearby surfaces, on the supporting surface, at points of support, on attachment plugs, and at other points determined to be necessary, including building wiring that may be located adjacent to or behind a permanently installed unit.

20.15 A unit intended to be permanently connected to the power supply or a unit that is cord connected and that is intended to be fastened in place or located in a dedicated space is to be supported in the intended manner on black painted wood not less than 9.5 mm (3/8 inch) thick. The unit is to be located in a corner – vertical walls meeting at a right angle – formed by two black painted, vertical sheets of 3/8 inch plywood having such width and height that they extend not less than 610 mm (2 ft) beyond the physical limits of the unit. The unit is to be located as close to both walls of the corner as its construction permits. It is to be placed relative to the walls so that maximum heating of the walls will occur, except that it may be spaced away from the walls to limit the wall temperatures from rising more than 65°C (117°F) if the unit is marked as described in 36.13.

20.16 A cord connected unit is to be supported on two layers of white tissue paper on a softwood surface.

20.17 An automatic temperature regulating or limiting control, or other protective device, is to be shunted out of the circuit, so that it will not operate during the test.

20.18 If the unit is constructed so that heating of a liquid is a determining factor in the temperature attained, the intended duty of a unit is to be taken into consideration. However, normal operating conditions cannot be obtained when certain types of units are operated continuously and in a dry condition. Accordingly, in determining whether a unit complies with the requirements in 20.1, actual service conditions or an approximation are to be used. Unless otherwise specifically indicated:

a) When the unit is controlled by an adjustable thermostat, the thermostat is to be set to give maximum temperatures; and

b) When the unit is controlled by a nonadjustable thermostat or cannot be adjusted by the end user, it is to operate at whatever temperature the thermostat permits.

In each case, operation is to be continued until temperatures are stabilized.

20.19 External thermal insulation, such as woven glass fiber or mineral wool, is to be removed before a unit is installed in the test enclosure unless the material is bonded or permanently attached to the unit. Rubber or other material similarly subject to deterioration is to be removed from feet or other supports if the removal of the material is likely to result in higher temperatures on the unit.

20.20 Wherever cheesecloth is mentioned in connection with either a temperature test or an abnormal test, the cloth is to be bleached cheesecloth running 14 – 15 yd/lb (approximately 28 – 30 m/kg) having what is known to the trade as a "count of 32 x 28" – for any square inch, 32 threads in one direction and 28 threads in the other direction (for the square centimeter, 13 threads in one direction and 11 threads in the other direction).

21 Ground Circuit Resistance Test

21.1 The resistance between the point of connection of the equipment grounding means at or within the product and any other point in the grounding circuit of the product shall not be more than 0.1 ohms as determined by an ohmmeter or other equivalent means.

21.2 If unacceptable results are observed with an ohmmeter, a low voltage current source can be employed. With the low voltage current source, an alternating current of 25 A (for 15 A maximum rated products) from a power supply of 12 V or less is to be passed for one minute minimum. The current shall be passed from the point of connection of the equipment grounding means to the metal part in the grounding circuit under test. The resulting drop in potential is to be measured between the two points, and the resistance is to be calculated.

22 Dielectric Test

22.1 A unit shall be capable of withstanding for 1 minute without breakdown a 60 Hz essentially sinusoidal potential applied between primary live parts and dead metal parts, and between primary live parts and isolated secondary circuits, with the unit at its maximum normal operating temperature. The test potential (rms) is to be 1000 V plus twice the rated voltage.

22.2 To determine whether a unit complies with the requirement in 22.1, the unit is to be tested by means of a 500 VA or larger capacity testing 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 value is reached, and held at that value for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as consistent with its value being correctly indicated by a voltmeter.

23 Cable Arcing Test

23.1 A cord or cable shall not result in a risk of fire when subjected to the test described in 23.2. The surgical cotton indicator shall not ignite.

23.2 The cord or cable is to be connected to the equipment and to the remote unit in the intended manner. The insulation of one of the conductors is to be removed so as to expose the conductor for a length of 1.6 mm (1/16 inch). Surgical cotton is to be placed in direct contact with the bared portion of the conductor. With the equipment operating at rated frequency and maximum voltage, a straight, brass pin

connected to a conductor of opposite polarity, or to other available return, is to be touched repeatedly during a 15 minute period to the bared conductor in an attempt to cause arcing.

24 Strain Relief Test

24.1 The strain relief means provided on an attached flexible cord shall not allow movement of the cord that would indicate stress on internal connections.

24.2 For this test, the internal connections for the conductors associated with the cord shall be disconnected.

24.3 The flexible cord shall be tested in accordance with 24.4 and 24.5.

24.4 A 15.9 kg (35 lb) weight is to be suspended on the cord and supported by the product so that the strain relief means will be stressed from any angle that the construction of the product permits. The weight is to be suspended for 1 minute.

24.5 The supply cord is to be held 25.4 mm (1 inch) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. When a removable bushing that extends further than 25.4 mm is present, it is to be removed prior to the test. When the bushing is an integral part of the cord, then the test is to be carried out by holding the bushing. The cord is to be pushed back into the product in 25.4 mm increments until the cord buckles or the force to push the cord into the product exceeds 26.7 N (6 lbf). The supply cord within the product is to be manipulated to determine compliance with this requirement.

25 Stalled Armature Switch Test

25.1 A switch or other device that controls a motor and that has not been previously investigated for its suitability of controlling a motor shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked rotor current of the motor. As a result of the test, there shall be no electrical or mechanical breakdown of the device. The fuse in the grounding connection shall not open.

Exception: This requirement does not apply to a switch or other device interlocked so that it does not have to break the locked rotor current of the motor.

25.2 In a test to determine whether a switch or other control device complies with the requirements in 25.1, the product is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage, with the rotor of the motor locked in position. During the test, exposed dead metal parts of the product are to be connected to ground through a 3 ampere plug fuse, and the connection is to be such that any single pole, current rupturing device is connected in the ungrounded conductor of the supply circuit. The device is to be operated at a maximum rate of 10 cycles per minute, except that a faster rate of operation is to be employed only when agreeable to all concerned.

26 Stability Test

26.1 The unit shall not overturn as a result of this test. In conducting the tests, the equipment is to be installed as intended. All casters and jacks, if provided, are to be placed in their most unfavorable positions, and wheels are to be locked or blocked.

26.2 A sample is to be placed on a plane inclined at an angle of 10 degrees to the horizontal. It is to be positioned and loaded with whatever combination of separable components, liquid, or other media that results in the maximum tendency to overturn under conditions of intended use. The unit is to be prevented from sliding on the inclined surface.