UL 751

STANDARD FOR SAFETY

Vending Machines

UL Standard for Safety for Vending Machines, UL 751

Ninth Edition, Dated July 18, 2016

Summary Of Topics

The revisions to ANSI/UL 751 dated October 2, 2018 reflects the latest ANSI affirmation date and includes the following changes in requirements:

Revisions To Update Requirements For Controls

Revision To And Addition Of Requirements To Prevent Remote Shut-Off Of Vending Machines

Revisions To Clarify The Scope Of The Standard

Revisions To And Addition Of Requirements To Address Switch Mode Power Supply Units Increasingly Used In Vending Machines

Revisions To Clarify Requirements For Vending Machines Having Two Supply Cords

Revisions To Marking Requirements To Clarify Application Of UL 969 Requirements

Revisions To EMI Filter Requirements To Specify An Alternate Compliance Option

Editorial Revisions To Clarify The Compliance Criteria Of the Leakage Current Test

Editorial Revisions To Include A List Of All Reference Standards (Designation And Title) Referenced In The Text Of The Standard

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 29, 2018.

In the revisions dated October 2, 2018 pages 54 and 55 have been intentionally deleted from the Standard due to the deletion or relocation of text.

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UL 751

Standard for Vending Machines

The First, Second, and Third editions were titled Standard for Safety for Vending and Amusement Machines.

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Ninth Edition

July 18, 2016

This ANSI/UL Standard for Safety consists of the Ninth Edition including revisions through October 2, 2018.

The most recent designation of ANSI/UL 751 as an American National Standard (ANSI) occurred on October 2, 2018. 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 self-contained, payment-accepting, vending machines that vend non-refrigerated products to be employed in accordance with ANSI/NFPA 70. Vending machines as covered by this standard are intended for indoor use only, except that they will be investigated for outdoor use or use in a protected location if so designated by the manufacturer. Vending machines may be battery operated and may be provided with a solar photovoltaic (PV) system. If a vending machine vends a non-refrigerated product but is provided with a refrigerated section, then the refrigerated section shall be evaluated to the relevant requirements in UL 541.

1.2 These requirements also cover vending machines intended for installation within motor fuel dispensing facilities in accordance with Supplement SA, Requirements for Vending Machines Intended for Installation within Motor Fuel Dispensing Facilities, and as defined by NFPA 30A.

1.3 These requirements do not cover sound-recording and reproducing machines.

1.4 These requirements do not cover vending machines intended to vend refrigerated products. Such products are covered by UL 541.

2 Units of Measurement

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

3 References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

ANSI Standards

ANSI Z97.1, *Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test*

ASME Standards

ASME B94.11, *Twist Drills*

ASTM Standards

ASTM A90/A90M, *Test Method of the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings*

ASTM A653/A653M, *Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM E162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*

IEC Standards

IEC 60127-1, *Miniature Fuses: Part 1, Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links*

IEC 60335-1, *Safety of Household and Similar Electrical Appliances, Part 1: General Requirements*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields*

IEC 61000-4-11, *Electromagnetic Compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests*

IEC 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at a.c. Power Port, Low Frequency Immunity Tests*

IEC 61000-4-34, *Electromagnetic Compatibility (EMC) – Part 4-34: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current More Than 16 A Per Phase*

NEMA Standards

NEMA WD6, *Wiring Devices – Dimensional Requirements*

NFPA Standards

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*

ANSI/NFPA 70, *National Electrical Code*

UL Standards

UL 1, *Flexible Metal Conduit*

UL 4, *Armored Cable*

UL 6, *Electrical Rigid Metal Conduit – Steel*

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 62, *Flexible Cords and Cables*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 101, *Leakage Current for Appliances*

UL 157, *Gasket and Seals*

UL 197, *Commercial Electric Cooking Appliances*

UL 224, *Extruded Insulating Tubing*

UL 244A, *Solid-State Controls for Appliances*

UL 248-1, *Low-Voltage Fuses – Part 1: General Requirements*

UL 248-4, *Low-Voltage Fuses – Part 4: Class CC Fuses*

UL 248-5, *Low-Voltage Fuses – Part 5: Class CC Fuses*

UL 248-8, *Low-Voltage Fuses – Part 8: Class J Fuses*

UL 248-9, *Low-Voltage Fuses – Part 9: Class K Fuses*

UL 248-10, *Low-Voltage Fuses – Part 10: Class L Fuses*

UL 248-11, *Low-Voltage Fuses – Part 11: Plug Fuses*

UL 248-12, *Low-Voltage Fuses – Part 12: Class R Fuses*

UL 248-14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 489A, *Circuit Breakers For Use in Communications Equipment*

UL 496, *Lampholders*

UL 498, *Attachment Plugs and Receptacles*

UL 499, *Electric Heating Appliances*

UL 508, *Industrial Control Equipment*

UL 508C, *Power Conversion Equipment*

UL 510, *Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape*

UL 514A, *Metallic Outlet Boxes*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 514C, *Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers*

UL 514D, *Cover Plates for Flush-Mounted Wiring Devices*

UL 541, *Refrigerated Vending Machines*

UL 542, *Fluorescent Lamp Starters*

UL 635, *Insulating Bushings*

UL 710B, *Recirculating Systems*

UL 719, *Nonmetallic Sheathed Cables*

UL 723, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 746E, *Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards*

UL 758, *Appliance Wiring Material*

UL 797, *Electrical Metallic Tubing – Steel*

UL 810, *Capacitors*

UL 817, *Cord Sets and Power Supply Cords*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 870, *Wireways, Auxiliary Gutters and Associated Fittings*

UL 917, *Clock-Operated Switches*

UL 923, *Microwave Cooking Appliances*

UL 935, *Fluorescent-Lamp Ballasts*

UL 943, *Ground Fault Circuit Interrupters*

UL 969, *Marking and Labeling Systems*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1004-7, *Electronically Protected Motors*

UL 1012, *Power Units Other Than Class 2*

UL 1029, *High-Intensity-Discharge Lamp Ballasts*

UL 1030, *Sheathed Heating Elements*

UL 1059, *Terminal Blocks*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

UL 1412, *Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances*

UL 1434, *Thermistor-Type Devices*

UL 1441, *Coated Electrical Sleeving*

UL 1446, *Insulating Materials – General*

UL 1449, *Surge Protective Devices*

UL 1557, *Electrically Isolated Semiconductor Devices*

UL 1565, *Positioning Devices*

UL 1577, *Optical Isolators*

UL 1642, *Lithium Batteries*

UL 1703, *Flat-Plate Photovoltaic Modules and Panels*

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*

UL 1977, *Component Connectors for Data, Signal, Control and Power Applications*

UL 2054, *Household and Commercial Batteries*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-4, *Fuseholders – Part 4: Class CC*

UL 4248-5, *Fuseholders – Part 5: Class G*

UL 4248-8, *Fuseholders – Part 8: Class J*

UL 4248-9, *Fuseholders – Part 9: Class K*

UL 4248-11, *Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse*

UL 4248-12, *Fuseholders – Part 12: Class R*

UL 4248-15, *Fuseholders – Part 15: Class T*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-2, *Low Voltage Transformers – Part 2: General Purpose Transformers*

UL 5058-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 8750, *Light Emitting Diode (LED) Equipment For Use in Lighting Products*

UL 60065, *Audio, Video and Similar Electronic Apparatus – Safety Requirements*

UL 60335-1, *Household and Similar Electrical Appliances, Part 1: General Requirements*

UL 60384-14, *Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains*

UL 60691, *Thermal-Links – Requirements and Application Guide*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-6, *Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements*

UL 60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

UL 60939-3, *Passive Filter Units for Electromagnetic Interference Suppression – Part 3: Passive Filter Units for Which Safety Tests are Appropriate*

UL 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

UL 61058-1, *Switches for Appliances – Part 1 General Requirements*

4 Terminology

4.1 In the following text, a requirement that does not apply to all of the types of vending machines covered by this standard is identified by a specific reference in that requirement to the type or types of vending machine involved. Absence of such specific reference or use of the term vending machine indicates that the requirement applies to all types of vending machines unless the context indicates otherwise.

4.2 Unless otherwise specified, values of voltage and current referred to are rms values.

5 Glossary

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

5.1.1 ACCESSORY – A device or component intended for installation in or connection to a vending machine for the purpose of modifying or supplementing the functions of the vender. It is intended for installation by the serviceman or another equally qualified person in the field. An accessory may be dependent upon the vending machine for electrical power, signaling, switching, or the like.

5.2 BARRIER – A partition for isolating high-voltage electrical components, separating ignition sources from flammable materials, isolating moving parts and protection of wiring.

5.3 CABINET – The part of the equipment that provides physical protection to insulated wiring, enclosures, moving parts, motors, enclosed electrical parts, tubing or other parts that may cause injury to persons.

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

5.4 CELL – The basic photovoltaic device that generates electricity when exposed to sunlight.

5.5 CHARGE CONTROLLER – Equipment that controls dc voltage or dc current, or both, used to charge a battery.

5.6 COMPONENT – A device or fabricated part of the vending machine covered by the scope of a safety standard dedicated to that purpose. If incorporated in a vending machine, a product that is otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

5.7 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the risk of electric shock, is considered an operating control. Operating controls are also referred to as ″regulating controls″. Appendix A specifies control functions that are not considered to result in a risk of fire, electric shock, or injury to persons.

5.8 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of fire, electric shock, or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as ″limiting controls″ or ″safety controls″ and are investigated under normal and single-fault conditions. Appendix A specifies control functions that are considered to result in a risk of fire, electric shock, or injury to persons. Such functions may also be defined as ″safety critical″.

5.9 CONVERTER – A device that accepts ac or dc power input and converts it to another form of ac or dc power.

5.10 ELECTRONIC COMPONENT – A part in which electrical conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor. A metal oxide varistor (MOV) is considered to be an electronic component, but neon indicators are not.

5.11 ELECTRONIC DISCONNECTION – The de-energizing of a load within an appliance by an electronic device of a circuit. No electro-mechanical component having an air gap, such as a switch, contactor or relay is used to de-energize the load.

5.12 ENCLOSURE – The part of the equipment that does one or more of the following:

a) Isolates ignition sources;

b) Renders inaccessible all or any part(s) of the equipment that may otherwise present a risk of electric shock; or

c) Retards propagation of flame initiated by electrical disturbances occurring within.

5.13 FIELD-WIRING TERMINAL – Any terminal to which a supply or other wire can be connected by an installer in the field, unless the wire is provided as part of the vending machine and a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire.

5.14 FUNCTIONAL PART – A part other than an enclosure or cabinet used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure.

5.15 GROUNDING, FUNCTIONAL – Grounding of a point in an appliance which is necessary for a purpose other than safety.

5.16 HIGH-VOLTAGE CIRCUIT – A high-voltage circuit is one involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit as defined in 5.21.

5.17 IGNITION SOURCE – Any high-voltage electrical component not located within an enclosure.

5.18 INTERACTIVE SYSTEM – A solar photovoltaic system providing power to a vending machine and operating in parallel with and may deliver power to an electrical production and distribution network.

5.19 INVERTER – Equipment that is used to change voltage level or waveform, or both, of electrical energy and typically changes dc input to an ac output.

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

5.21 LOW-VOLTAGE CIRCUIT – A low-voltage circuit is one involving a potential of not more than 30 volts alternating current, 42.4 volts peak or direct current, and supplied by a standard Class 2 transformer or by a suitable combination of transformer and fixed impedance having output characteristics in compliance with those required for a Class 2 transformer.

5.22 MODULE – A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of the tracker, designed to generate dc power when exposed to sunlight.

5.23 MOTOR CONTROLLER – Any device normally used to start and stop a motor, such as a switch, thermostat, pressure limiting control, or the like.

5.24 NONFUNCTIONAL PART – A part of the equipment that does not perform a specific function.

5.25 NONFUNCTIONAL PART, SMALL – A nonfunctional part having an area of less than 1 ft^2(0.093 m^2) located so it cannot propagate flame from one area to another, and does not connect a possible source of ignition to the other ignitable parts.

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

5.26.1 POTENTIALLY HAZARDOUS FOOD – A natural or synthetic substance intended for internal human consumption and which requires temperature control since it is capable of supporting growth of toxic microorganisms.

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

5.28 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions.

5.29 ROUTE PERSON – A person who regularly opens a vending machine for such purposes as cleaning, removing coins, making minor adjustments, price changing, and replenishing the product supply.

5.30 SERVICE PERSON – A person who may periodically open a vending machine to repair or maintain electrical or mechanical components.

5.31 SOLAR PHOTOVOLTAIC (PV) SYSTEM – The total components and subsystems that, in combination, convert solar energy into electric energy suitable for connection to a load such as a vending machine.

5.32 STAND-ALONE SYSTEM – A solar photovoltaic system that supplies power independently of an electrical production and distribution network. Such a system is not intended to be connected to an electrical production and distribution network.

5.32.1 SWITCH MODE POWER SUPPLY UNIT – Electronic device incorporating transformer(s) and electronic circuitry(ies), that converts electrical power into single or multiple power outputs by rapidly switching a solid-state device on and off. It may also isolate the input circuit from the output circuit and regulate and/or convert the output voltage and current. The device may consist of one or more individual units with identical or different waveforms and frequencies including dc output.

5.33 THERMISTOR – A thermally sensitive semiconductor resistor, which shows over at least part of its resistance/temperature characteristic a significant non-linear change in its electrical resistance with a change in temperature. A thermistor may be either of the positive temperature coefficient (PTC) type or of the negative temperature coefficient (NTC) type.

5.34 VENDING MACHINE – Any self-service device that dispenses products or merchandise without the necessity of replenishing the device between each vending operation and designed to require insertion of a coin, paper currency, token, card, key or receipt of payment by other means.

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

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CONSTRUCTION

6 General

6.1 If the deterioration or breakage of any part that contains, conducts, or otherwise contacts a liquid could result in a risk of fire, electric shock, or injury to persons, the part shall be of a material resistant to corrosion by the liquid to be used therein and shall have sufficient strength for the pressures involved.

6.2 If a liquid, powder, or other material that must be replenished, removed, or replaced is present, spilled material shall be prevented from contacting live parts, and any other risk of fire, electric shock, or injury to persons that could result from filling, emptying, storing, normal movement of the vending machine, or the like, shall be prevented from occurring.

6.3 A component shall:

a) Comply with the safety standard covering that component;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability; and

d) Comply with the applicable requirements of this end product standard.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product;

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

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

6.4 A component that is also required to perform other necessary functions, such as overcurrent protection, ground-fault circuit interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) covering products that provide those functions.

7 Nonmetallic Parts

7.1 All nonmetallic parts, other than small nonfunctional parts, shall comply with Sections 8 – 10 and Table 74.1.

7.2 In addition to the requirement in 7.1, nonmetallic materials that serve as electrical insulation or that directly support live parts shall comply with the requirements for electric insulation in UL 746C.

8 Nonmetallic Materials

8.1 Materials shall be classified with respect to flammability characteristics that are established by the tests specified in UL 94.

8.2 Materials shall be assigned flammability ratings based on greatest to least resistance to flame and are identified as: 5VA, 5VB, V-0, V-1, V-2, HF-1, HF-2, HB, and HBF.

8.3 In reference to 8.2, the assigned flammability rating shall be appropriate for the material-use application in accordance with Nonmetallic Material Ignition Sources Separation, Section 9 and Table 74.1.

9 Nonmetallic Material Ignition Sources Separation

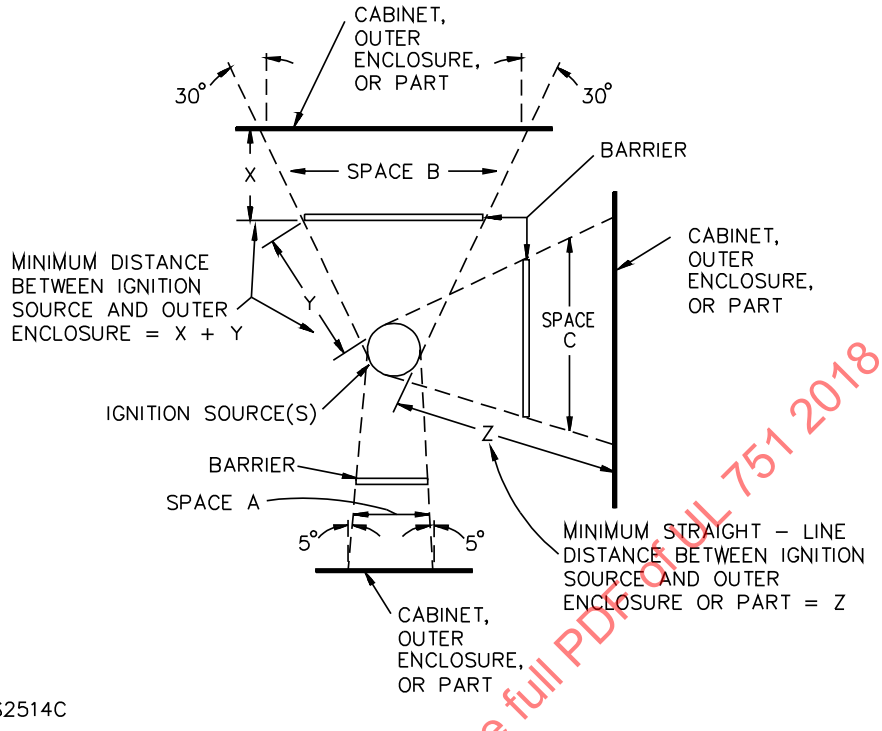
9.1 Parts formed from nonmetallic materials that are rated HB or HBF and positioned as shown in Figure 9.1 shall be separated from ignition sources by means of a barrier, extending at least to the boundary surface of the space whenever such parts are located:

a) Below an ignition source and within Space A;

b) Above an ignition source and within Space B; and

c) In the vertical plane relative to an ignition source and within Space C.

Figure 9.1
Separation of ignition sources from nonmetallic materials



9.2 The HB or HBF materials referenced by 9.1 shall be located such that the distance between:

a) High-voltage wiring not employing VW-1 insulation and the HB or HBF materials shall be a minimum of 2 inches (51 mm); and

b) Any other ignition source and the HB or HBF materials shall be a minimum of 4 inches (102 mm).

9.3 With reference to 9.2 and Figure 9.1, the minimum distance for HB or HBF materials located:

a) Above the ignition source shall be as shown in Distance X + Y; and

b) In the vertical plane relative to the ignition source shall be as shown in straight-line Distance Z.

10 Nonmetallic Material Application and Location

10.1 Nonmetallic materials shall comply with the applicable tests as described in Table 74.1.

10.2 Nonmetallic fasteners used as a part of the enclosure shall comply with the Fastener Strength Test, Section 75.

11 Barriers

11.1 A barrier shall be formed from one or more of the following:

a) Metal, minimum 0.005 inch (0.13 mm) thick;

b) Fiberglass, minimum 0.5 inch (12.7 mm) thick;

c) A nonmetallic material rated 5VA;

d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in UL 746C;

e) Vulcanized fiber, varnished cloth or phenolic composition, minimum 0.028 in. (0.71 mm) thick; or

f) Any other material or construction determined to be equivalent to (a) to (e).

11.2 A barrier shall be secured to the mounting surface such that tools are required for its removal.

11.3 Other than as specified in 19.1.4, 26.8 and 47.4(d) a nonmetallic barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 74.1.

11.4 A nonmetallic barrier providing mechanical protection shall comply with the cabinet requirements of Table 74.1.

12 Frame and Enclosure

12.1 A vending machine 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.

12.2 Among the factors taken into consideration when an enclosure is being judged are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

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

f) Resistance to atmospheric effects – rain and sunlight in the case of a vending machine intended for outdoor use. For a nonmetallic enclosure all of these factors are considered with respect to thermal aging.

12.3 A cast- or sheet-metal section of the enclosure shall have a thickness not less than that specified in Table 12.1.

Table 12.1
Minimum acceptable thickness of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size that provides adequate mechanical strength		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	Inch	(mm)	Inch	(mm)	Inch	(mm)
Die-case metal	3/64	(1.2)	–		5/64	(2.0)
Case-malleable iron	1/16	(1.6)	–		3/32	(2.4)
Other cast metal	3/32	(2.4)	–		1/8	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029	(0.74)	0.034	(0.86)	0.029	(0.74)
Nonferrous sheet metal	0.036	(0.91)	0.045	(1.14)	0.036	(0.91)

12.4 The enclosure of a vending machine shall prevent molten metal, burning insulation, flaming particles, and the like from falling on combustible materials, including the surface upon which the vending machine is supported.

12.5 The requirement in 12.4 necessitates the use of a barrier or pan of noncombustible material:

a) Under a motor unless:

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

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

i) Open main winding;

ii) Open auxiliary winding; and

iii) Starting switch short-circuited; 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:

i) 125°C (257°F) when the motor is running at the maximum load at which it can operate without causing the protector to cycle; and

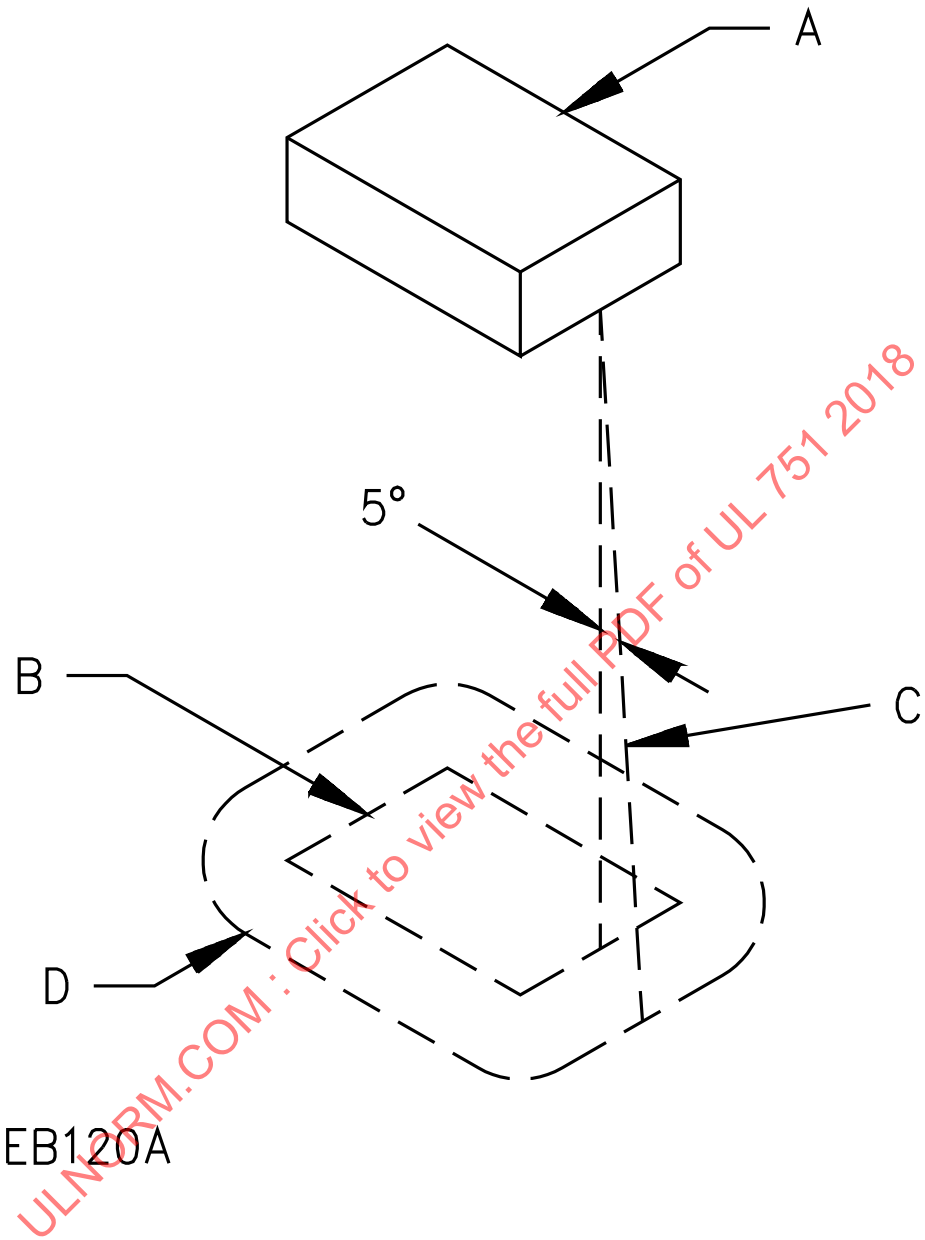
ii) 150°C (302°F) with the rotor of the motor locked.

b) Under wire, unless it is of the flame-retardant type, such as thermoplastic- and neoprene-insulated wire; and

c) Under a switch, relay, solenoid, transformer, or the like unless it can be shown that malfunction or breakdown of the component would not result in a risk of fire.

12.6 The barrier mentioned in 12.5 shall be horizontal, located as illustrated in Figure 12.1, and have an area in accordance with that figure.

Figure 12.1
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. When moving, 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.

12.7 A glass panel used for the enclosure of electrical parts or that is subject to contact during intended use or maintenance of the vending machine, or both, shall be supported or secured in place and shall comply with Glass Strength Test, Section 70.

12.8 Exterior glass having an exposed minor dimension greater than 12 in (305 mm) and an area greater than 1 ft^2(0.029 m^2) shall comply with the Impact Test, Section 70.1.

12.9 Exterior glass having an exposed minor dimension greater than 3 in (76 mm) shall comply with the Mechanical Pressure Test, Section 70.2.

12.10 Other than as specified in 12.11 – 12.13, glass that is subject to contact during use and routine maintenance of the vending machine shall not have a thickness less than 0.115 in (2.92 mm), and shall comply with Impact Test, Section 70.1 or Mechanical Pressure Test, Section 70.2.

12.11 The effects of the following factors shall be considered in the investigation of glass panels heated by electrically conductive surfaces or other means:

a) Electrical input;

b) Temperature rise;

c) Operation of overvoltage condition;

d) Ability to withstand dielectric potential;

e) Reliability of vapor seal;

f) Resistance to moisture;

g) Stability of conductive coating;

h) Aging of terminal assemblies;

i) Resistance to impact; and

j) Resistance to thermal shock.

12.12 A glass component, other than a lamp, used inside a vending machine shall have smooth edges if the edges are exposed to contact during routine use, including cleaning. Edges that are exposed when the glass component is in its intended storage position shall be fire polished, heat-toughened or tempered, or covered by permanently attached smooth framing.

12.13 The glass components specified in 12.12 shall comply with Glass Component Strength Test, Section 71.

12.14 Each gasket required to seal an electrical enclosure against the entrance of rain and condensate shall comply with Accelerated Aging Test of Gaskets, Section 72, or with UL 157 if the gasket physical properties are equivalent to those specified in Section 72. In addition, each gasket shall:

a) Be neoprene, rubber, thermoplastic or other materials with equivalent properties that comply with Accelerated Aging Test of Gaskets, Section 72; and

b) Be held in place by mechanical fasteners or adhesives, except as specified in 12.15.

12.15 In reference to 12.14, gaskets which are not held in place by mechanical fasteners or adhesives but are intended to be retained in the correct position by some other means shall be prevented from displacement either:

a) Due to their location within the equipment; or

b) By the placement of other components in the enclosure so that if the equipment cover is removed, the gasket will be reengaged in the intended manner when the cover is replaced.

13 Mechanical Assembly

13.1 The assembly of a vending machine shall provide for easy installation and removal of tanks and containers that must be removed and replaced by the route person. Removal and replacement of tanks and containers shall not result in a risk of fire, electric shock, or injury to persons. The removal and replacement of these vessels or the product or ingredients shall not result in damage to wiring, electrical components, or refrigerant-containing parts.

13.2 A vending machine shall be assembled so that it will not be adversely affected by vibration during intended operation.

13.3 A switch, a fuseholder, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar components subject to manual operation or manipulation shall be mounted securely and shall be prevented from turning or shifting. See 13.4 and 13.5.

Exception: A switch need not comply with this requirement if the following conditions are met:

a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated – a toggle switch is considered to be subjected to forces that tend to turn the switch during normal operation of the switch;

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

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

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

13.4 Uninsulated live parts and components that have 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 displacement could result in a reduction of spacings below the minimum values specified in Spacings, Section 46. See 13.3.

13.5 The means for preventing the turning or shifting mentioned in 13.3 and 13.4 shall consist of more than friction between surfaces – for example, a lock washer, properly applied, is acceptable as a means to prevent turning or shifting of live parts or a device having a single-hole mounting means.

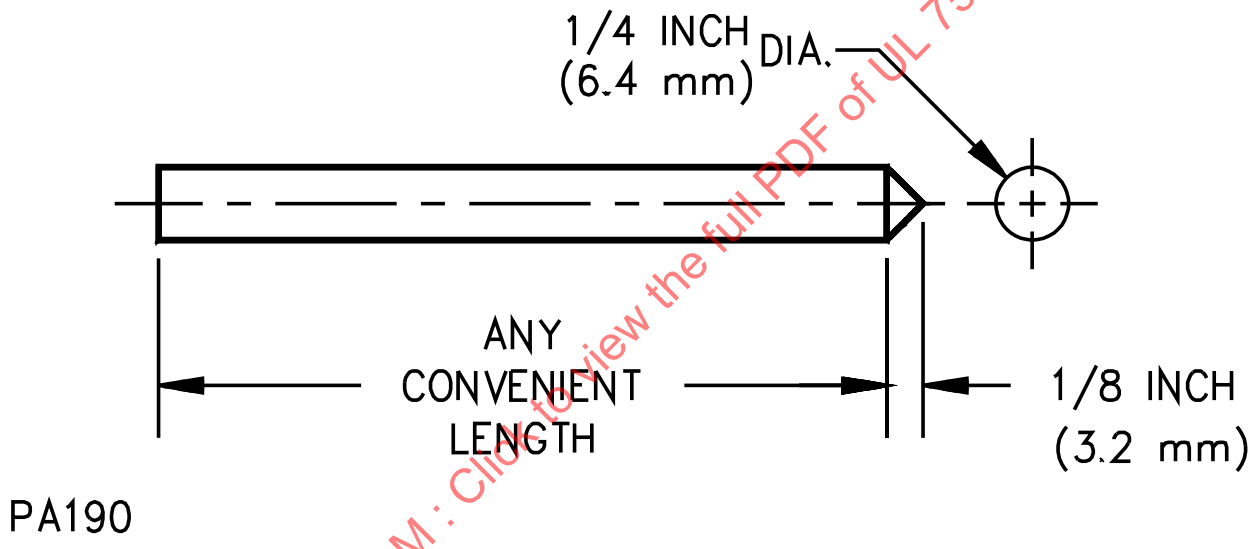
14 Accessibility of Live Parts

14.1 Electrical parts of a vending machine shall be located or enclosed so that persons are protected against unintentional contact with uninsulated live parts. The method of judging openings in the enclosure is given in 14.2 and 14.3. Also see 14.5 – 14.7.

Exception: A live part may be accessible if the voltage is 42.4 volts peak or less or if the available current measured through a 1500-ohm noninductive resistor is 5 milliamperes or less.

14.2 An opening in the enclosure of a vending machine is acceptable if a probe as illustrated in Figure 14.1 cannot be made to touch any uninsulated live part or film-coated wire when inserted through the opening.

Figure 14.1
Probe for uninsulated live part



14.3 Behind a locked door, an opening:

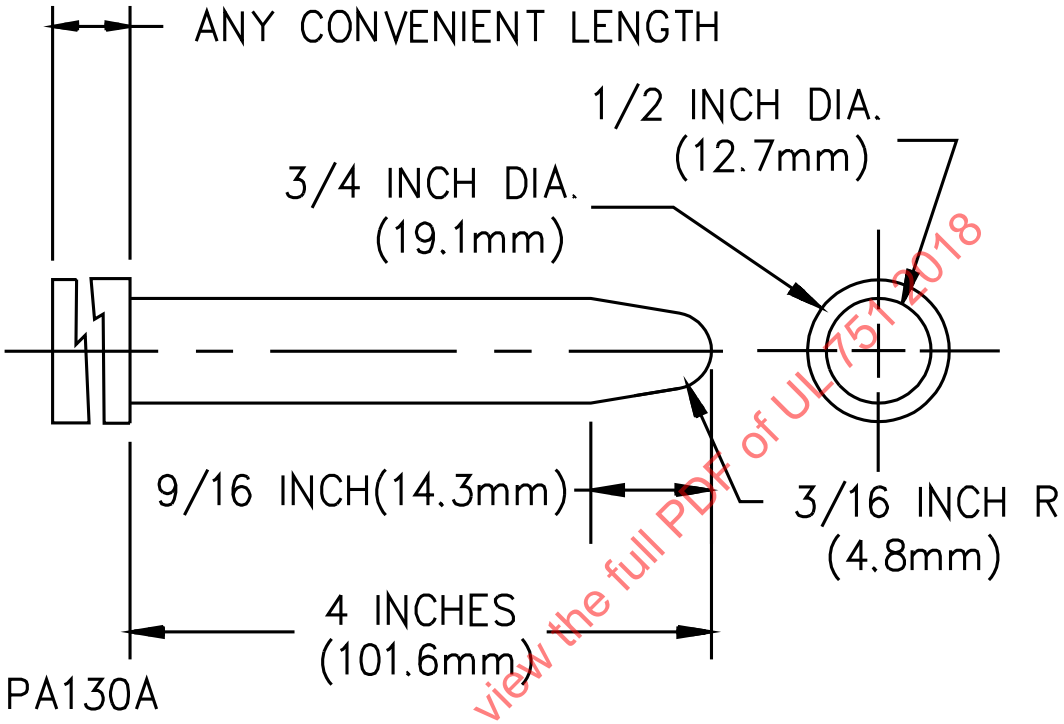
a) That will not permit entrance of a 3/4-inch (19.1-mm) diameter rod is acceptable if:

i) A probe as illustrated in Figure 14.2 cannot be made to touch any uninsulated live part when inserted through the opening; and

ii) A probe as illustrated in Figure 14.3 cannot be made to touch film-coated wire when inserted through the opening.

b) That will permit entrance of a 3/4-inch diameter rod is acceptable under the conditions illustrated in Figure 14.4 and described in 14.4.

Figure 14.2
Probe for uninsulated live part behind a locked door



14.4 An opening as illustrated in Figure 14.4 is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire less than X distance from the perimeter of the opening, as well as within the volume generated by projecting the perimeter distance X normal to its plane. X equals five times the diameter of the largest circular rod that can be inserted through the opening, but not less than 4 inches (102 mm). In evaluating an opening, any barrier located within the volume usually is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

Figure 14.3
Probe for film-coated wire

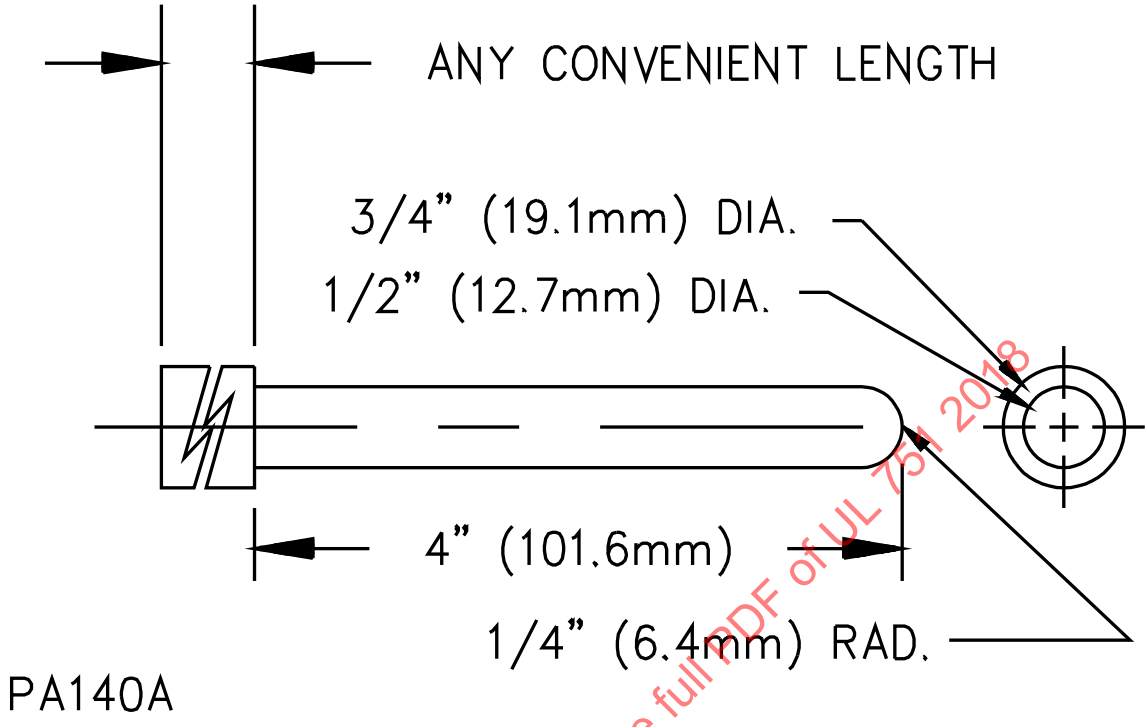
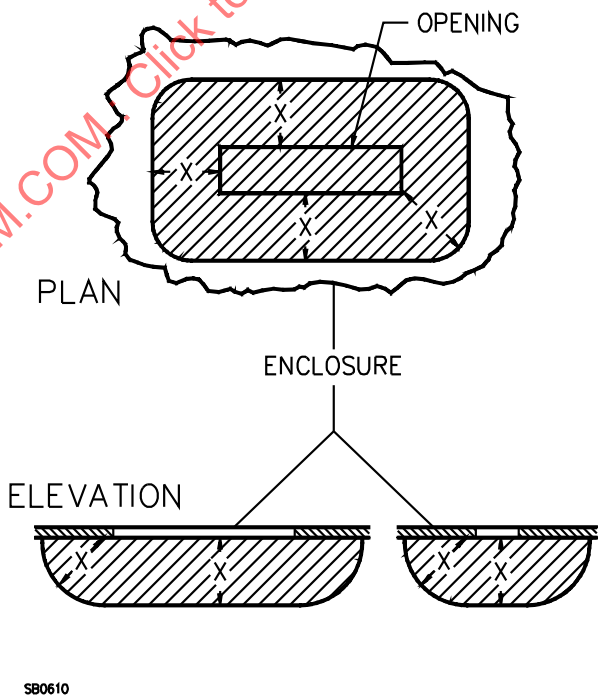


Figure 14.4
Opening in enclosure
Proportions Exaggerated for Clarity



14.5 When a vending machine is examined in connection with the requirement in 14.1, it is assumed that any part of the outer enclosure that can be removed without the use of tools or keys does not provide protection against electric shock.

14.6 An uninsulated live part shall be located or guarded so that it is not likely to be contacted by a route person while performing such routine, periodic service operations as collecting, relamping, lubricating, or control adjusting.

Exception: A live part may be accessible if the voltage is 42.4 volts peak or less or if the available current measured through a 1500-ohm noninductive resistor is 5 milliamperes or less.

14.7 The requirement in 14.6 will necessitate the use of an enclosure, cover, or barrier over an uninsulated live part that the route person may inadvertently touch while servicing or adjusting the vending machine. A cover or barrier that must be removed to perform a servicing function is not considered to provide the required protection.

14.8 Unless the vending machine is marked in compliance with 81.2, a lampholder, a fuseholder, and a circuit breaker shall be installed or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a lampholder or plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder will not be exposed to contact by persons servicing the lamp, fuse, or circuit breaker. A separation of less than 4 inches (102 mm) from the insulating body of a fuse is considered to be adjacent. A barrier of vulcanized fiber or similar material employed as a guard for uninsulated high-voltage live parts shall be at least 0.028 inch (0.71 mm) thick.

15 Protection Against Corrosion

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

Exception No. 1: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like, need not be protected against corrosion.

Exception No. 2: The sheath of a heating element other than the immersion type need not be protected against corrosion.

Exception No. 3: If the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast-iron parts within an enclosure may not be required to be protected against corrosion.

15.2 The sheath employed to enclose a heating element of an immersion-type heater shall be of a metal resistant to corrosion by the liquid in which the heater is intended to be immersed.

15.3 An electrical enclosure of sheet steel exposed to the effects of weathering shall be protected against corrosion as specified in 15.4 – 15.9 or by other metallic or nonmetallic coatings that have been shown to give equivalent protection.

15.4 The requirements of 15.3 do not apply to a motor enclosure if the motor is contained within the vending machine enclosure.

15.5 An enclosure with a thickness of 0.053 in (1.35 mm) or greater and that is contained within another enclosure, shall be protected by one of the following coatings:

a) Hot-dipped mill-galvanized sheet steel that complies with ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM designation. The weight of the coating is to be established using any method acceptable for the purpose. In case of question, the weight of coating is to be established in accordance with the test method of ASTM A90/A90M.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 in (10.4 µm) on each surface with a minimum thickness of 0.00034 in (8.6 µm). The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 64.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The suitability of the paint is to be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

15.6 For an enclosure intended to provide the only enclosure of a current-carrying part or has a thickness less than 0.053 in (1.35 mm), protection shall be provided by one of the following coatings:

a) Hot-dipped mill-galvanized sheet steel that complies with ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM designation. The weight of the coating is to be established using any method acceptable for the purpose. In case of question, the weight of coating is to be established in accordance with the test method of .

b) A zinc coating, other than that provided in ASTM A90/A90Mn hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 in (15.5 µm) on each surface with a minimum thickness of 0.00054 in (13.7 µm). The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 64. An annealed coating shall also comply with the requirements in 15.7.

c) A cadmium coating with a thickness not less than 0.001 in (25 µm) on both surfaces. The thickness of the coating is to be determined by the Metallic Coating Thickness Test, Section 64.

d) A zinc coating that complies with 15.5(a) or (b) with one coat of outdoor paint – applied after forming – as specified in 15.5(c).

e) A cadmium coating with a thickness not less than 0.00075 in (19.1 µm) on both surfaces with one coat of outdoor paint on both surfaces, or with a thickness not less than 0.0005 in (13 µm) on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating is to be determined by the Metallic Coating Thickness Test, Section 64 and the paint shall be as specified in 15.5(c).

15.7 An annealed zinc coating that is bent or similarly formed after annealing shall additionally be painted in the bent or formed area if the bending or forming process damages the zinc coating.

15.8 If flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered damaged. Simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes shall conform with 15.7.

15.9 With reference to 15.3, other finishes, including paints, metallic finishes and combinations of the two may be acceptable when comparative tests with galvanized sheet steel, without annealing, wiping, or other surface treatment, conforming with 15.5(a) or 15.6(a), as applicable, indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light, and water.

16 Supply Connections For Cord Connected Vending Machines

16.1 Cords and plugs

16.1.1 A vending machine intended for cord connection to the power supply shall be equipped with a flexible non-detachable power supply cord having an equipment grounding conductor and with a grounding-type attachment plug.

16.1.2 In reference to 16.1.1, a power supply cord and plug shall comply with UL 817.

16.1.3 The length of the power supply cord shall not be greater than 10 feet (3.0 m) nor less than 6 feet (1.83 m). The length shall be measured between the attachment plug and any point at which the cord exits the vending machine cabinet or the last strain relief, whichever is shorter.

16.1.4 A cord-connected vending machine shall be provided with a factory installed ground-fault circuit-interrupter (GFCI).

16.1.5 The GFCI shall comply with UL 943 and be either:

a) An integral part of the attachment plug; or

b) Located such that it is in the supply cord within 12 in (305 mm) of the attachment plug.

16.1.6 The GFCI on a vending machine intended for outdoor use shall be rated for outdoor use.

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

Exception: The ampacity of the power supply cord need not be greater than the ampere rating of the attachment plug.

16.1.8 The flexible cord shall be Type S, SE, SEO, SJ, SJE, SJEO, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, ST, STO, or STOO as specified in ANSI/NFPA 70. The cord of a vending machine intended for use in a protected location or an outdoor location shall be marked on the jacket with the designation of ″W″ following the cord type designation.

16.1.9 The attachment plug shall have an ampacity not less than the rated current at a voltage equal to the rated voltage of the vending machine. If a vending machine is intended for continuous operation for 3 hours or more, the current rating of the attachment plug shall be at least 125 percent of the rating of the vending machine.

16.1.10 Other than as indicated in 16.1.11, the grounding-type attachment-plug shall comply with the ANSI designation as specified in Table 16.1 based on the vending machine voltage and ampere rating.

16.1.11 In reference to 16.1.10, if the grounding-type attachment plug does not comply with the ANSI designation specified in Table 16.1, then the equipment shall be rated 250 V or less and shall be intended for connection to circuits rated for other than:

a) 60 Hz; and/or

b) The voltages specified in 58.1.6.

Table 16.1
ANSI designation for attachment plug

Attachment plug rating	ANSI designation[a]
15 amperes, 125 volts	5-15
20 amperes, 125 volts	5-20
30 amperes, 125 volts	5-30
15 amperes, 250 volts	6-15
20 amperes, 250 volts	6-20
30 amperes, 250 volts	6-30

[a] Designations in accordance with ANSI/NEMA WD6

16.1.12 The power supply cord equipment grounding conductor shall be:

a) Finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified;

b) Secured to the frame or enclosure of the vending machine by a positive means that is not likely to be removed during any servicing operation not involving the power supply cord. A sheet metal screw or quick-connect terminal shall not be used; and

c) Connected to the grounding blade of the attachment plug.

16.1.13 Except as specified in 16.1.14, if an accessory is powered from a source of supply separate from that supplying a cord-connected vending machine, disconnection of any one power-supply cord shall automatically cause de-energization of all circuits within the vending machine and accessory.

16.1.14 With reference to 16.1.13, if a vending machine does not automatically de-energize all circuits, then the vending machine shall be provided with the marking specified in 81.8.

16.1.15 A cord connected vending machine and any intended accessory(ies) provided with more than one power supply cord shall comply with all of the following:

a) The equipment shall consist of two separate units joined together;

b) Not more than two cords shall be provided;

c) Each cord shall be of the type and rating specified in 16.1.8 and provided with an equipment grounding conductor in accordance with 16.1.12;

d) Each attachment plug shall be as specified in 16.1.9 – 16.1.11;

e) The markings specified in 81.9(a) and (c) shall be provided; and,

g) The instructions shall contain the information specified in 80.3.4.

16.1.16 In reference to 16.1.15, if the combined rated current input to both supply cords exceeds 80 percent of the branch circuit to which the equipment will be connected, then the unit or cord with the highest rated current input shall be marked adjacent to the supply cord in accordance with 81.9(b).

16.2 Strain relief

16.2.1 Strain relief shall be provided to prevent mechanical stress on a flexible cord from being transmitted to terminals, splices, or interior wiring. See Strain Relief Test, Section 68.

16.2.2 If a flexible cord is capable of being pushed into the vending machine through the cord-entry hole, any such displacement shall not result in:

a) Mechanical damage to the cord;

b) Exposing the cord to a temperature higher than that for which it is rated;

c) Reducing spacings, such as to a metal strain-relief clamp, below the minimum required values; or

d) Damaging internal connections or components.

Compliance shall be determined in accordance with Push-Back Strain-Relief Test, Section 69.

16.2.3 If a knot in a flexible cord serves as strain relief, the surfaces that the knot may touch shall be free from burrs, fins, sharp edges, and projections that can damage the cord.

17 Supply Connections for Permanently Connected Vending Machines

17.1 General

17.1.1 A vending machine of the following types shall have provision for permanent connection to the power supply in accordance with ANSI/NFPA 70:

a) A vending machine rated more than 250 volts; or

b) A polyphase vending machine.

17.2 Field-wiring compartments

17.2.1 A field-wiring compartment in which power-supply connections are to be made shall be located so that these connections may be readily inspected after the vending machine has been installed as intended. The connections shall be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

17.2.2 A field-wiring compartment intended for connection of a supply raceway shall be attached to the vending machine so as to be prevented from turning.

17.3 Field-wiring terminals and leads

17.3.1 General

17.3.1.1 A vending machine shall be provided with field-wiring terminals or leads for the connection of supply-circuit conductors. The terminals or leads shall not be less than the size required by ANSI/NFPA 70 having an ampacity acceptable for the rating of the vending machine.

17.3.1.2 As used in Terminals, Section 17.3.2 and Leads, Section 17.3.3, a field-wiring terminal is considered to be a terminal to which power supply, control, or equipment grounding connections will be made in the field when the vending machine is installed.

17.3.1.3 The wiring of a permanently connected vending machine shall terminate in an outlet box or similar compartment with provision for the connection of metal-clad cable or conduit, or shall have provisions for the connection of a nonmetallic wiring system which, in accordance with ANSI/NFPA 70, would be acceptable for connection to the vending machine.

17.3.1.4 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 17.3.1.1 using Type TW or THW wire when at least a 6 inch (150 mm) length of each conductor is brought into the wiring compartment.

Exception: Conductors other than Type TW or THW may be used if specified in the installation instructions.

17.3.2 Terminals

17.3.2.1 Pressure wire connectors shall be used for field-wiring terminals except that for field-wiring terminals intended for 8 AWG (8.4 mm^2) and smaller conductors, the parts to which wiring connections are made may consist of clamps or wire binding screws with cupped washers, terminal plates, or the equivalent to hold the wire in position.

17.3.2.2 Size 14 AWG (2.1 mm^2) wire shall be considered as being the smallest wire that can be used for branch circuit wiring and at a terminal intended for the connection of the power supply leads.

17.3.2.3 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size specified in 17.3.1.1, but no smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

17.3.2.4 Wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with 17.3.2.5 – 17.3.2.10 or with UL 486E.

17.3.2.5 If a wire-binding screw is employed at a wiring terminal for the connection of supply circuit conductors, it shall not be:

a) Smaller than 8 (4.2 mm diameter) for 14 AWG (2.1 mm^2) supply circuit conductors; or

b) Smaller than 10 (4.8 mm diameter) for 12, 10, or 8 AWG (3.3, 5.3, or 8.3 mm^2) supply circuit conductors.

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

Exception: A plate not less than 0.030 inch (0.76 mm) thick is acceptable for 14 AWG (2.1 mm^2) conductors.

17.3.2.7 A terminal plate formed from stock having the thickness specified in 17.3.2.6, may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

17.3.2.8 A wire-binding screw shall thread into metal.

17.3.2.9 A field-wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by such means as two screws or rivets; by square shoulders or mortises; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part.

17.3.2.10 A field-wiring terminal for the connection of a grounded conductor shall be identified by means of a metallic-plated coating, substantially white in color, and shall be distinguishable from the other terminals; or identification of the terminal for the connection of the grounded conductor shall be shown in some other manner, such as on an attached wiring diagram.

17.3.3 Leads

17.3.3.1 Leads intended for connection to any external high-voltage circuit or to an external low-voltage circuit that contain one or more of the components specified in 46.2.3 shall comply with all of the following:

a) Be one of the types of wiring specified in 20.2.2;

b) Be 6 inches (152 mm) or more in length, as measured from the lead end to the strain relief means, unless the use of a shorter lead is required to prevent damage to the lead insulation;

c) Be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. Leads shall comply with 48.1 when subjected to a direct pull of 20 pounds-force (89 N);

d) Not be connected to wire binding screws or pressure wire connectors located in the same compartment as the lead ends (that are intended for spliced connections to the field-wiring) unless the screws or connectors are rendered unusable for field-wiring connections or the lead ends are insulated; and

e) Be insulated at the free end, if the lead will not be used in every installation and if the end can reduce spacings below the minimum acceptable values specified in High Voltage Circuits, Section 46.1 for high-voltage circuits or Low-Voltage Circuits, Section 46.2 for low-voltage circuits.

17.3.3.2 A lead intended for the connection of a grounded conductor shall be finished to show a white or gray color, shall be distinguishable from other leads, and no other lead shall be so identified.

17.4 Equipment grounding

17.4.1 An equipment-grounding terminal or lead shall be provided on the vending machine.

17.4.2 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size suitable for the application. See 17.4.5.

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

17.4.4 The requirements in 17.3.2.10, 17.3.3.2, and 17.4.3 relating to color coding for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

17.4.5 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 for connection of such a conductor shall be plainly identified, such as by being marked, ″G,″ ″GR,″ ″GND,″ ″Ground,″ ″Grounding,″ or the like, or by a marking on a wiring diagram provided on the vending machine.

17.4.6 The wire-binding screw or pressure wire connector referred to in 17.4.5 shall be located so that it is unlikely to be removed during the normal servicing of the vending machine and shall have upturned lugs or the equivalent to retain the conductor.

18 Current-Carrying Parts

18.1 A current-carrying part shall be of silver, copper, copper alloy, stainless steel or other metal acceptable for the application.

18.2 With reference to 18.1, iron or steel shall not be used for a current-carrying part unless it is provided with a corrosion-resistant coating used within a motor or associated governor.

18.3 Plated iron or steel may be used for a current-carrying part of a heating element if the temperature of such part exceeds 100°C (212°F) under any condition of normal operation of the product. Stainless steel or other corrosion-resistant alloy may be used for a current-carrying part of a heating element without restriction as to temperature.

19 Insulating Material

19.1 Electrical insulation

19.1.1 Porcelain, phenolic composition, or other material acceptable for the application shall be used for the mounting of uninsulated live parts.

19.1.2 Ordinary vulcanized fiber may be used for an insulating bushing, a washer, a separator, and a barrier, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock.

19.1.3 Thermoplastic materials generally are not considered to be acceptable for the sole support of uninsulated live parts, but may be employed if found to have mechanical strength and rigidity, resistance to heat, resistance to flame spread, dielectric strength, and other properties acceptable for the application.

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

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

Exception No. 2: Insulating material having a thickness less than 1/32 inch may be used if, upon investigation, it is found to be acceptable for the particular application.

19.1.5 A small molded part, such as a brush cap, shall be constructed so as to have the necessary mechanical strength and rigidity to withstand the stresses of actual service. A brush cap shall be secured or located so as to be protected from mechanical damage that might result during intended use.

19.1.6 Electrical insulation that does not comply with 19.1.1 – 19.1.5 shall comply with one of the following:

a) Film-coated wire or materials used in an insulation system that operates at or above Class 105 (Class A) shall comply with UL 1446. The requirements for film-coated wire or materials used in insulation systems that operate below Class 105 (Class A) are not specified.

b) Insulating tape shall comply with UL 510.

c) Insulating sleeving shall comply with UL 1441.

d) Insulating tubing shall comply with UL 224.

19.2 Thermal insulation

19.2.1 Thermal insulating material shall be acceptable for the application. Combustible or electrically-conductive thermal insulation shall not contact an uninsulated live part of the vending machine.

20 Internal Wiring

20.1 General

20.1.1 The wiring and connections between parts within a vending machine shall be protected or enclosed.

20.1.2 With reference to 20.1.1, wiring is considered to be protected if the wiring:

a) Is evaluated as if it were film-coated wire and complies with 14.2 – 14.7; or

b) Conductor insulation is as specified in 20.1.3 – 20.1.6.

20.1.3 Other than as specified in 20.1.4, 20.1.5, or 20.1.6, wiring conductor insulation shall be neoprene, thermoplastic or rubber not less than 1/16 inch (1.6 mm) thick for 16 AWG (1.3 mm^2) and smaller conductors, and 5/64 inch (1.98 mm) thick for 14, 12 or 10 AWG (2.1, 3.3 or 5.3 mm^2) conductors.

20.1.4 Wiring with neoprene or thermoplastic conductor insulation that does not comply with 20.1.3 shall have insulation not less than 1/32 inch (0.8 mm) thick. In addition such wiring shall be:

a) Contained within a separate metal enclosure, conduit, electrical metallic tubing, metal raceways, or the equivalent;

b) Contained within insulating tubing that complies with UL 224, and having a wall thickness not less than 0.028 inch (0.71 mm);

c) Not longer than 3 inches (76.2 mm) and intended to facilitate connection to electrical components. Such wiring shall be protected against damage by its location or routing; or

d) Arranged so that the wires are:

1) Not subjected to movement by air or vibration;

2) Secured at intervals and bunched together to form a cable;

3) Routed in a manner to prevent hooking by a route or service person, including being located away from reset buttons, test switches, or similar components;

4) Located in a compartment which is provided with a complete base pan or similar bottom closure;

5) Routed to prevent contact through openings in the outer enclosure or cabinet in accordance with 14.3(a)(i) and 14.3(b); and

6) Not routed between stationary and movable parts.

20.1.5 Wiring with rubber insulation that does not comply with 20.1.3 shall be not less than 3/64 inch (1.2 mm) thick. In addition such wiring shall comply with 20.1.4(a), (b), or (c).

20.1.6 Wiring with conductor insulation that does not comply with 20.1.3 shall be not less than 1/64 inch (0.4 mm) thick. In addition, such wiring shall be located inside an enclosure within the vending machine cabinet and not likely to be contacted by a route person.

20.1.7 Wiring that may be exposed to the route person shall be routed or secured to prevent it from being unintentionally hooked or damaged.

20.1.8 If any failure of low-voltage wiring may cause malfunctioning of a pressure-limiting device, motor overload protective device, or other protective device, where short-circuiting or grounding may result in unsafe operation of the vending machine, such wiring shall comply with 20.1.3 – 20.1.7.

20.2 Wires

20.2.1 The internal wiring of a vending machine shall have insulation rated for the potential involved and the temperatures to which it may be subjected. Compliance shall be determined in accordance with one of the following:

a) Wiring temperatures shall be evaluated on the basis of the temperatures measured during the applicable temperature test specified in Temperature Test, Section 58.

b) Other than motor wiring, all wiring shall:

1) Have an ampacity of the conductors in accordance with Table 20.1; and

2) Not be exposed to heat from radiating sources or heated components.

c) Motor wiring shall have an ampacity not less than 125 percent of the motor full load current rating in addition to complying with (b).

Table 20.1

Wiring material ampacities

AWG	(mm^2)	Ampacity, A[a]
22	(0.41)	4
20	(0.66)	7
18	(0.82)	10
16	(1.3)	13
14	(2.1)	18
12	(3.3)	25
10	(5.3)	30
8	(8.4)	40
6	(13.3)	55
4	(21.2)	70
2	(33.6)	95
1	(42.4)	110

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Continued

AWG	(mm^2)	Ampacity, A[a]
[a] The ampacities shown apply to appliance wiring materials with insulation rated not less than 194°F (90°C). For types of wires other than appliance wiring materials, the ampacity shall be determined from Tables 310-16 and 310-21 in ANSI/NFPA 70, for the type of wire employed. The correction factors of the referenced tables need not be applied.		

20.2.2 Wiring shall comply with UL 44, UL 62, UL 83, or UL 758.

20.2.3 Wiring in a refrigeration section shall be evaluated in accordance with Internal Wiring, Section 20.

Exception: The requirement in 20.1.6 shall not be applied.

20.2.4 Wiring and any supplementary insulation provided shall be subjected to the Flexing of Internal Wiring, Section 67, if movement of the wiring is likely to cause a risk of fire or electric shock.

20.2.5 Impregnated or unimpregnated cotton- or asbestos-insulated wire shall not be employed.

20.2.6 With reference to 20.2.1, high voltage circuit conductors supplying more than one motor shall have an ampacity not less than 125 percent of the full load current rating of the largest motor plus the full load current rating of any other motors supplied. Conductors supplying a motor load and other loads shall have an ampacity not less than 125 percent of the motor full load current rating plus the marked current ratings or measured inputs of the additional loads supplied.

20.2.7 Wiring which is color coded green or green with one or more yellow stripes shall be used only for grounding conductors. Wiring used for other purposes shall not be identified with the above color codes.

20.3 Routing

20.3.1 Metal clamps and guides used for routing stationary internal wiring shall have smooth, rounded edges. Wire positioning devices shall comply with UL 1565.

20.3.2 Wires shall be reliably routed away from sharp edges, screw threads, burrs, fins, moving parts, or the like, that may abrade the insulation on the wires.

20.3.3 Holes in walls, panels, or barriers through which insulated wires or cords pass and on which they may bear shall be provided with smoothly rounded bushings or shall have smooth, rounded surfaces upon which the wires or cords may bear to prevent abrasion of the insulation. Bushings shall comply with UL 635 or be fabricated from materials, such as ceramic, wood, phenolic, porcelain, cold-molded composition, or fiber and be reliably secured in place.

21 Splices and Connections

21.1 Splices and connections shall:

a) Comply with UL 486A-486B or UL 486C. In determining if splice insulation consisting of coated fabric, thermoplastic, or other type of tubing is acceptable, consideration shall be given to such factors as its electrical, mechanical, and flammability properties; and

b) Be mechanically secure and shall provide reliable electrical contact.

21.2 Quick connecting assemblies shall comply with UL 310, form a secure electrical connection, and be capable of carrying the current involved.

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

21.4 In a vending machine in which excessive vibration is likely to occur, the requirement in 21.1 will necessitate the use of lock washers or other means to prevent wire-binding screws and nuts from loosening.

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

21.6 If the voltage involved is less than 250 volts, insulation consisting of two layers of thermoplastic tape, or two layers of friction tape, or one layer of friction tape and one layer of rubber tape, that has been investigated and found acceptable for the purpose is acceptable on a splice. In determining if splice insulation consisting of coated fabric, thermoplastic, or other tubing is acceptable, consideration is to be given to such factors as its electrical and mechanical properties and its flammability.

21.7 Thermoplastic tape shall not be wrapped over a sharp edge.

21.8 Splicing devices such as pressure wire connectors may be employed if they provide the necessary mechanical security and insulation for the voltage and temperature to which they are subjected.

21.9 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 the use of a pressure terminal connector, a soldering lug, a crimped eyelet, soldering of all strands together, or other reliable means.

21.10 Open-end connectors are not acceptable unless they are provided with upturned ends that will hold the connector in place if the screw becomes slightly loose.

22 Separation of Circuits

22.1 Unless provided with insulation appropriate for the highest voltage involved, insulated conductors of different circuits within a vending machine shall be separated by barriers or shall be segregated, and shall, in any case, be separated or segregated from uninsulated live parts connected to different circuits.

22.2 Segregation of insulated conductors may be accomplished by clamping, routing, or other equivalent means that will maintain permanent separation from insulated or uninsulated live parts of a different circuit.

22.3 Field-installed conductors of any circuit shall be segregated or separated by barriers from field-installed and factory-installed conductors of any other circuit unless the conductors of both circuits are or will be insulated for the maximum voltage of either circuit.

22.4 A barrier used to provide separation between the wiring of different circuits shall comply with Barriers, Section 11 and be rigid insulating material.

23 Heating Elements

23.1 A heating element shall:

a) Comply with the construction requirements of either UL 499 or UL 1030; and

b) Be protected against mechanical damage and contact with outside objects.

23.2 A heating element shall be supported to prevent sagging, loosening or any other adverse conditions of the element that results from continuous heating.

24 Motors

24.1 General

24.1.1 A motor shall be capable of handling the maximum normal load of the vending machine as described in 58.2.1 – 58.2.3 without introducing a risk of fire, electric shock, or injury to persons.

24.2 Overload protection

24.2.1 Each motor shall be provided with overload protection.

Exception No. 1: A motor that is used for air-handling only – direct drive blower or ventilating fan – is considered to have overload protection if it is protected against locked-rotor conditions only.

Exception No. 2: A single-coil, shaded-pole motor having a 2 to 1 or less current ratio between locked-rotor current and no-load current is considered to have overload protection if it is protected against locked-rotor conditions only.

24.2.2 The motor overload protection required by 24.2.1 shall consist of one of the following:

a) Electronic protection in accordance with Protective Electronic Circuits, Section 24.3 or complying with UL 1004-7; or

b) Impedance protection complying with UL 1004-2;

c) Thermal protection complying with UL 1004-3; or

d) Other protection that is shown by tests to be equivalent to the protection specified in (a), (b), or (c).

24.2.3 Unless additional protection is provided in the vending machine, a device providing overload protection for a motor shall be acceptable for use on a branch circuit to which the vending machine is intended to be connected.

24.2.4 The functioning of an overload-protective device provided for a motor as part of a vending machine, whether or not such a device is required, shall not result in a risk of fire, electric shock, or injury to persons. See 50.2.1.

24.3 Protective electronic circuits

24.3.1 A protective electronic circuit providing motor protection in accordance with Overload Protection, Section 24.2 shall comply with one of the following:

a) *Deleted.*

b) UL 60730-1 and the specific applicable UL 60730 Part 2 Standard.

c) Paragraph 26.25 and the Protective Electronic Circuits Tests, Section 76; or,

d) Not create any risk of fire, electric shock or injury to persons under abnormal conditions with the protective electronic circuit rendered ineffective (open or short-circuited), e.g. use of a redundant circuit or control.

24.3.2 With reference to 24.3.1, the following items shall be considered when evaluating the acceptability of a motor protective electronic circuit:

a) A failure-mode and effect analysis (FMEA);

b) Electrical supervision of critical components resulting in a trouble indication;

c) Temperature ranges are as follows:

1) Indoor Use: 32.0 ±3.6°F (0.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C);

2) Protected Locations and Outdoor Use: -31.0 ±3.6°F (-35.0 ±2°C) and 104 ±3.6°F (40.0 ±2°C);

d) Cycling Test duration shall be 14 days;

e) Endurance Test duration shall be 100,000 cycles;

f) Radio-frequency electromagnetic field immunity: radiated electromagnetic fields – Evaluate in accordance with 76.3.4 and 76.3.2;

g) Exposure to humidity with the following conditions:

1) Indoor use: 70 – 80°F (21.1 – 26.7°C) and minimum 50 percent relative humidity;

2) Protected Locations and Outdoor Use: minimum 98 percent relative humidity;

h) Electrical Fast Transient/Burst Immunity Test:

1) Indoor Use: Test Level 3;

2) Protected Locations and Outdoor Use: Test Level 4;

i) Radio-frequency electromagnetic field immunity: conducted disturbances – Test Level 3;

j) Surge Immunity Test:

1) Indoor Use: Class 3;

2) Protected Locations and Outdoor Use: Class 4;

k) Electrostatic Discharge Test – Severity Level 3 for:

1) Control discharge of up to 6 kV for accessible metal;

2) Air discharge of up to 8 kV for accessible metal parts of insulating material.

l) Voltage Dips and Interruptions – Evaluate in accordance with 76.3.8 and 76.3.2;

m) Harmonics and Interharmonics – Evaluate in accordance with 76.3.9 and 76.3.2; and

n) Calibration (deviation and drift): Evaluate in accordance with 26.13 for a temperature protective control or 26.14 for a pressure protective control.

24.3.3 Software in a protective electronic circuit required as part of a motor protective device or system shall comply with one of the following standards:

a) *Deleted.*

b) UL 60730-1 as well as the specific applicable Part 2 and be software Class B.

c) UL 60335-1 and be software Class B; or

d) Not create any risk of fire, electric shock or injury to persons under abnormal conditions with the software rendered ineffective, e.g. use of independent redundant protective devices.

25 Overcurrent Protection

25.1 General

25.1.1 Other than as indicated in 25.1.2, overcurrent protection at not more than 20 amperes shall be provided by a circuit breaker or fuse, as a part of a vending machine, for each general-use receptacle circuit and each lampholder circuit included in the vending machine.

25.1.2 In reference to 25.1.1, if overcurrent protection is not provided, a vending machine shall be intended for connection to a branch circuit rated 20 amperes or less.

25.1.3 Fuses used for compliance with 25.1.1 or 25.2.1 shall comply with UL 248-1, in conjunction with UL 248-4, UL 248-5, UL 248-8, UL 248-9, UL 248-10, UL 248-11, UL 248-12, or UL 248-15, as applicable for the class of fuse.

25.1.4 Circuit breakers used for compliance with 25.1.1 or 25.2.1 shall comply with UL 489. In addition, circuit breakers used in telecommunications circuitry shall comply with UL 489A.

25.1.5 An overcurrent protective device required for compliance with 25.1.1 or 25.2.1 shall be electrically connected in the ungrounded side of the circuit.

25.1.6 Circuit breakers used to protect circuits having more than one ungrounded conductor and no grounded neutral shall be of the multipole common trip type arranged to open all ungrounded conductors. The use of external handle ties does not in itself constitute a common trip mechanism.

25.1.7 A fusing resistor or supplementary protector shall not be used in place of a circuit breaker or protective control.

25.1.8 Fusing resistors shall comply with UL 1412.

25.1.9 Supplementary protectors shall comply with UL 1077.

25.1.10 A supplementary fuse shall comply with UL 248-1, in conjunction with UL 248-14.

25.1.11 A fuseholder or circuit breaker shall be acceptable for the application and shall not be accessible from outside the vending machine without opening a door or cover.

Exception: The operating handle of a circuit breaker may project outside the enclosure.

25.1.12 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.

25.2 Motors and power transformers

25.2.1 Other than as indicated in 25.2.2, a motor or power transformer in a vending machine rated more than 20 amperes shall be protected by an overcurrent device having a maximum ampere rating in accordance with ANSI/NFPA 70. Such overcurrent protection shall be provided as a part of the vending machine unless it can be determined that equivalent overcurrent protection would be incorporated as the branch circuit protective device.

25.2.2 A power transformer that does not comply with 25.2.1 shall be:

a) Used only to energize a motor control circuit;

b) Rated less than 50 VA; and

c) Located within the same enclosure as the motor-controller.

26 Switches and Controllers

26.1 Except as specified in 26.2 or 26.3, a switch or other control device shall have a rating not less than that of the load that it controls. Items to consider in determining the device rating could include the voltage, current, power factor, control device, ambient temperature and other similar parameters. Power factor requirements for each specific load type are specified in 66.5 (a) – (d).

26.2 If a switch or other similar device does not comply with 26.1 and is used:

a) To control only one motor, the device shall comply with the Overload of Motor Switches or Controllers Test, Section 65.

b) To control an inductive load (other than a motor), such as a transformer or an electric-discharge-lamp ballast, the device shall:

1) Be rated for not less than twice the full-load current of the transformer or ballast;

2) Have an inductive rating at least equal to the load it controls; or

3) Comply with the Overload and Endurance Test – Switching Devices, Section 66.

c) In applications other than controlling a tungsten-filament-lamp load or other than as specified in (a) or (b), the device shall comply with the Overload and Endurance Test – Switching Devices, Section 66.

26.3 A switch that controls a lampholder for an incandescent lamp other than a 15-watt or smaller pilot or indicating lamp shall have a tungsten-filament-lamp load rating at least equal to the load it controls.

26.4 A motor controller shall be provided in a cord-connected vending machine employing a motor rated more than 1/3 horsepower (250 W output).

26.5 A single-pole switching device, including an automatic control having a marked “off” position, shall not be connected to the identified (grounded) conductor.

26.6 If malfunction of a protective (limiting) control can result in a risk of fire due to overheating of the vending machine, a backup protective control shall be provided to limit temperature.

26.7 A protective control shall:

a) Be an integral part of the vending machine; and

b) Control the load(s) directly other than as indicated in 26.12.

26.8 Except as specified in 26.11, a protective control shall comply with one of the following standards:

a) *Deleted*

b) UL 60730-1 and UL 60730-2-6. The endurance cycle requirements in Table AA.1DV of UL 60730-2-6 for cut-outs shall be applied.

c) UL 60730-1 and UL 60730-2-9. The endurance cycle requirements in Table CC.2 of UL 60730-2-9 for cut-outs shall be applied.

d) *Deleted*

e) UL 508.

f) *Deleted*

g) UL 61058-1; or

h) Paragraph 26.25 and the Protective Electronic Circuits Tests, Section 76.

26.9 In reference to 26.8 (e) – (h), the endurance cycle requirements in UL 60730-2-9, Table CC.2, for cut-outs shall be applied to such controls.

26.10 In reference to 26.8 (b), (c), (g) and (h), when determining the acceptability of a protective control, the control pollution degree shall be as specified in 46.3.3 (a) – (d). If the protective control:

a) Has a protective electronic circuit, the items in 24.3.2 (a) – (k) shall be considered; and

b) Uses software as a required part of the protective electronic circuit, the software shall comply with 24.3.3 (b) or (c).

26.11 In reference to 26.8, a device providing motor overload protection shall comply with the requirements in Motors, Section 24.

26.12 If a protective control indirectly controls the load through a switching device, the switching device shall comply with the endurance cycle requirements for protective controls in 26.8 and 26.9 and be an integral part of the vending machine.

26.13 The cutout calibration temperature of a heater protective (temperature-limiting) control shall be ±10°F (±6°C) of its maximum marked set-point temperature.

26.14 The cutout calibration pressure of a pressure protective (limiting) control shall not exceed 105 percent of its maximum marked setting.

26.15 Except as specified in 26.19, an operating control, including of the electronic type, shall comply with:

a) One of the standards specified in 26.8;

b) The requirements in this Standard as far as they reasonably apply; or

c) UL 244A, UL 508C, or UL 917.

26.16 If a thermal cutoff or other device is employed to prevent a risk of fire due to overheating of a vending machine during abnormal operation as specified in 26.6, it shall comply with the requirements applicable to such a device in addition to the applicable requirements of this standard. For example, a thermal cutoff shall comply with the applicable requirements in this standard and those in UL 60691.

26.17 A general-use snap switch shall comply with UL 20.

26.18 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector.

26.19 An operating control not complying with 26.15 shall:

a) Be powered entirely by no more than one low-voltage circuit;

b) Comply with the Limiting Impedance Test in UL 508; or

c) Comply with the low-power test requirement determined as specified in 19.11.1, of UL 60335-1.

26.20 An operating control complying with 26.15 shall also comply with the following:

a) For electronic controls – Installation Class 2 for electromagnetic compatibility (EMC) shall be in accordance with the voltage surge testing in 76.3.6 and comply with the results specified in 76.3.2;

b) Category II shall be the overvoltage category;

c) Insulating materials shall have a minimum comparative tracking index (CTI) of 100 (Material Group III);

d) The applicable pollution degree shall be as specified in 46.3.3 (a) – (d); and

e) The endurance cycle requirements specified by:

1) Table CC.2 of UL 60730-2-9, with the operating control (limiters) endurance cycle requirements being applied; or

2) The Overload and Endurance Test – Switching Devices, Section 66, if the operating control is used to control a load other than a single motor or the Overload of Motors Switches or Controllers Test, Section 65, if the operating control is used to control a single motor.

26.21 Appendix A, Operating and Protective ("Safety Critical") Control Functions, shall be referenced to determine whether a control function is considered to result in a risk of electrical shock, fire or injury to persons.

26.22 If an operating control complying with 26.15 indirectly controls the load through a switching device, the endurance cycle requirements in 26.20(e) shall be applied to the switching device.

26.23 If a control can be used to reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, but a redundant control (of similar or different design) operates to perform the identical function, the circuit shall be evaluated to determine which control will be relied upon as the protective control. The control determined to be the protective control shall comply with the protective control requirements in 26.8. The control determined to be the operating control is not required to comply with the protective control requirements but shall comply with the operating control requirements in 26.19 or with 26.15 and 26.20.

26.24 A thermistor shall comply with UL 60730-1 or UL 1434. The calibration shall be as specified in 26.13. If a thermistor is used:

a) To reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, the minimum number of endurance cycles shall be 100,000.

b) In other sensing applications of the appliance, the minimum number of endurance cycles shall be 6,000.

26.25 A protective control as referenced in 24.3.1(c) or 26.8(h) and having a protective electronic circuit:

a) In which electronic disconnection of the circuit could fail, shall have at least two components whose combined operation provides the load disconnection;

b) Shall prevent a risk of fire, electric shock or injury to persons under the relevant fault conditions specified in Fault Conditions Abnormal Tests, Section 76.2;

c) In which an overcurrent protective device opens during application of any of the fault conditions specified in Fault Conditions Abnormal Tests, Section 76.2, shall utilize an overcurrent protective device complying with the requirements applicable to that component. The fault condition causing the overcurrent protective device to open shall be repeated and the overcurrent protective device shall again open the protective electronic circuit. If the overcurrent protective device complies with IEC 60127-1, as well as an applicable Part 2, then the protective device shall additionally comply with the Fuse-Link Test, Section 76.5;

d) In which a conductor of the printed wiring board becomes open-circuited during the fault conditions test in Fault Conditions Abnormal Tests, Section 76.2; then

1) The printed wiring board shall comply with the Needle-Flame Test in Annex E of UL 60335-1 or have a minimum flammability rating of V-0 when tested in accordance with the vertical flame test described in UL 94;

2) Any loosened conductor shall not reduce spacings below the values specified in the relevant Sections 46.1 – 46.3; and

3) The specific test in which the printed wiring became open-circuited shall be repeated a second time. There shall be no risk of fire, electric shock or injury to persons and spacings shall not be reduced below the values specified in the relevant Sections 46.1 – 46.3;

e) Shall maintain its required functions when subjected to the EMC related stresses specified in the Electromagnetic Compatibility (EMC) Tests, Section 76.3; and

f) That relies upon a programmable component for one or more of its safety functions shall be subjected to the Programmable Component Reduced Supply Voltage Test, Section 76.4, unless restarting at any point in the operating cycle after interruption of operation due to a supply voltage dip will not result in a risk of fire, electric shock or injury to persons. The test shall be carried out after removal of all batteries and other components intended to maintain the programmable component supply voltage during supply source (mains) voltage dips, interruptions and variations.

27 Remotely Operated Vending Machines

27.1 Any vending machine function enabled in response to external communication or data signals shall be considered when determining normal and abnormal conditions of the appliance.

27.2 Except as specified in 27.3, a manual control shall be provided on a vending machine such that actuation of the control is required before the vending machine can be operated in any mode that permits remote operation, external communication or receiving/sending data signals.

27.3 In reference to 27.2, a vending machine not provided with a manual control for actuating remote operation, external communication or receiving/sending data signals shall be:

a) Capable of remote operation, external communication or receiving/sending data signals only within line-of-sight; or

b) Limited only to monitoring external communication or data signals.

27.4 A vending machine shall include a means to manually disconnect, disable or override any remote operation commands, external communication or data signals. For cord-connected vending machines, if the vending machine attachment plug and receptacle serve as the manual means to disconnect data signals or remote operation commands, the vending machine shall be rated no more than the value specified in 26.4. In addition, the vending machine instructions shall comply with 80.3.3.

27.5 A control that operates in response to remote operation commands, external communication or data signals shall not introduce an operating condition or state that could lead to a risk of fire, electric shock or injury to persons. In addition, such a control shall not:

a) Render inoperative any protective control or protective control function within the vending machine;

b) Alter the order of control response such as by forcing a protective control to operate instead of another control that would normally be intended to respond;

c) Reset any protective manual reset feature;

d) Supersede the response of any protective control;

e) Allow remote shut-off of a vending machine intended for use with potentially hazardous foods; or,

f) Alter the response to or expected performance of:

1) User actuation of controls, movement of doors, covers, grills, filters or the like; or

2) User interaction with any parts of the vending machine that could result in exposure of hazardous electrical parts, moving parts, hot parts or radiation.

27.6 Compliance with 27.5 shall be determined by one of the following:

a) Using methods appropriate for determining the performance and reliability of protective control functions in accordance with Switches and Controllers, Section 26; or

b) Examining the vending machine circuit diagram(s) to determine that a control which operates in response to remote operation commands, external communication or data signals operates wholly independent of the vending machine protective controls and therefore is incapable of adversely affecting the operation of any protective controls

28 Capacitors

28.1 A motor-starting or running capacitor shall comply with UL 810. A capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall comply with UL 60384-14. If a capacitor does not comply with either UL 810 or UL 60384-14 then the capacitor shall:

a) Be housed within an enclosure or container that will reduce the risk of mechanical damage to the plates and the emission of flame or molten material resulting from breakdown of the capacitor;

b) The capacitor container shall be metal providing strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.51 mm); and

c) Under both normal and abnormal conditions of use, a capacitor shall be constructed to reduce the likelihood of expelling the dielectric medium.

28.2 In reference to 28.1(b), if a capacitor sheet-steel container is thinner than 0.020 inch (0.51 mm) or of other material, it shall be mounted in an enclosure that houses other parts of the vending machine and that is intended for the enclosure of live parts.

28.3 In reference to 28.1, if a capacitor complies with UL 60384-14, it shall have specifications as follows:

a) Operating voltage – Not less than 110 percent of the vending machine rated voltage.

b) For capacitors connected across the line (phase-to-phase) – Subclass X1 (≤ 4.0 kV) or X2 (≤ 2.5 kV) for impulse voltage (based on minimum Overvoltage Category of II).

c) For capacitors connected from line to ground – Subclass Y1 or Y2 for any vending machines having a rated voltage not exceeding 500 volts; or as an alternate, subclass Y4 if a vending machine has a rated voltage not exceeding 150 volts.

d) Upper category temperature – Based on the maximum capacitor surface temperature measured during the Temperature Test, Section 58, but not less than 185°F (85°C).

e) Lower category temperature – Based on the minimum surface temperature for which the capacitor has been designed to operate when installed within a vending machine as intended, but not greater than 14°F (-10°C).

f) Duration of the Damp-Heat Steady-State Test – Not less than 21 days.

g) Passive flammability category B or C. As an alternate, a polymeric capacitor case shall have a V-0 flame rating as described in UL 94.

28.4 In reference to 28.3, a capacitor shall consist of a single Class Y1 capacitor or two Class Y2 capacitors connected in series if it is connected between:

a) Two line conductors in a primary circuit;

b) One line conductor and the neutral conductor;

c) Primary and accessible secondary circuits; or,

d) The primary circuit and protective earth (equipment grounding conductor connection).

29 Receptacles

29.1 A receptacle provided on a vending machine shall comply with UL 498, be of a grounding type and be bonded to the frame of the vending machine.

29.2 The face of a receptacle shall:

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

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

29.3 Unless intended to be connected to a power supply separate from that supplying other loads, a receptacle shall be rated at 15 or 20 amp, 125 or 250 V.

29.4 Receptacles shall be mounted with the receptacle face not less than 60 degrees from the horizontal and located so that liquid due to overflow, splashing, leakage, and cleaning will not enter.

29.5 Overcurrent protection shall be provided as part of the vending machine for each receptacle. The overcurrent protection shall be provided in accordance with Overcurrent Protection – General, Section 25.1.

30 Batteries and Battery Chargers

30.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in UL 1642. A lithium ion muiltiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in UL 2054.

30.2 Rechargeable nickel cadmium (Ni-Cad) and nickel metal-hydride (Ni-MH) battery cells and packs shall comply with the requirements in this Standard and with the applicable requirements for secondary cells or battery packs in UL 2054.

30.3 A battery charger shall comply with 39.1.

31 Connectors

31.1 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with UL 1977.

32 Cooking Equipment

32.1 Cooking equipment used in a vending machine shall comply with UL 197.

32.2 Cooking equipment provided with an integral recirculating system (ductless hood) or a nonintegral recirculating system intended to capture air from the cooking process area shall comply with UL 710B.

32.3 Microwave cooking equipment used in a vending machine shall comply with UL 923.

32.4 In reference to 1.1, if a vending machine is provided with a refrigerated section but vends a non-refrigerated product, the refrigerated section shall comply with UL 541.

33 Electrical Cable, Conduit and Tubing

33.1 Aluminum or steel armored cable shall comply with UL 4. Nonmetallic sheathed cables shall comply with UL 719.

33.2 Flexible metal conduit shall comply with UL 1. Rigid steel conduit shall comply with UL 6.

33.3 Electrical steel tubing shall comply with UL 797.

34 Electromagnetic Interference Filters

34.1 Electromagnetic interference filters shall comply with UL 1283 or UL 60939-3.

35 Fuseholders

35.1 Fuseholders shall comply with UL 4248-1, in conjunction with UL 4248-4, UL 4248-5, UL 4248-8, UL 4248-9, UL 4248-11, UL 4248-12, or UL 4248-15, as applicable for the class of fuseholder.

35.2 A plug fuseholder used in a high-voltage circuit shall be wired in the unidentified (ungrounded) conductor with the screw shell connected toward the load.

36 Lighting Systems

36.1 General

36.1.1 Lampholders and indicating lamps shall comply with UL 496.

36.1.2 Light Emitting Diode (LED) light sources shall comply with UL 8750.

36.1.3 If a vending machine is intended to be connected to the identified (grounded) conductor of a power supply circuit, a lampholder with a screw shell base shall be wired so that the screw shell will be connected to the identified conductor.

36.2 Electric-discharge lighting systems

36.2.1 Lighting ballasts shall comply with UL 935 or UL 1029.

36.2.2 The fluorescent lamp starters shall comply with UL 542.

36.2.3 Equipment for use with electric-discharge lighting systems in a vending machine shall be constructed for an open-circuit potential of not more than 1000 volts.

36.2.4 A vending machine employing electric-discharge lamps shall be provided with a ballast intended for the operation of lamps of the size for which the cabinet is constructed and shall be wired in accordance with the diagram or instructions on the ballast.

36.2.5 A vending machine provided with an instant-start ballast which involves a potential of more than 300 volts but not more than 600 volts shall be provided with lampholders of the circuit-interrupting type at the low-voltage end of the lamps.

Exception: Nonshort-circuiting type lampholders may be used if the vending machine is plainly marked (visible during relamping) in letters at least 1/8 inch (3.2 mm) in height to indicate that it is for use with instant-start lamps.

36.2.6 An electric-discharge lighting system shall have no live parts normally exposed that may be contacted by persons.

36.2.7 An electric-discharge lighting system which involves a potential of more than 300 volts shall be such that no uninsulated live parts will be accessible when the lamps are in place or removed, or while they are being inserted or removed.

36.2.8 The terminals of a lamp are considered to be live parts when any terminal of that lamp is in contact with an uninsulated live part involving a potential of more than 300 volts.

36.2.9 Except where electric lampholders having recessed inaccessible contacts intended for use with lamps having recessed inaccessible contacts are employed, compliance with 36.2.7 will require:

a) The use of lampholders so constructed and wired that when a lamp is removed, the potential in that lamp circuit is less than 300 volts; or

b) That the primary circuit be open during the relamping operation and all live parts be inaccessible when the lamps are removed and the primary circuit is reestablished.

36.2.10 Lampholders and ballasts installed in moist areas of a vending machine shall be constructed of moisture resistant materials or treated to resist absorption of moisture.

36.2.11 Other than as indicated in 36.2.12, ballasts shall be provided with a housing of nonflammable, moisture-resistant material.

36.2.12 In reference to 36.2.11, a ballast not provided with a housing shall be a reactor-type ballast of the open-core-and-coil type and be either completely enclosed or be provided within a compartment that complies with 36.2.13.

36.2.13 A vent opening in an open-core-and-coil reactor type ballast compartment in the form of a slot or louver shall be not more than 3/8 inch (9.5 mm) wide or more than 1-1/2 in^2(9.68 cm^2) in area, and any other ventilating openings shall be not more than 1/2 inch (12.7 mm) square. Ventilating openings shall not be located in the top or bottom of a ballast compartment mounted on a vertical surface and shall be located not less than:

a) 5 inches (127 mm) from surfaces of flammable material; or

b) 1/2 inch (12.7 mm) from surfaces of flammable material if the openings are perpendicular to or face completely away from the flammable material.

37 Optical Isolators and Semiconductor Devices

37.1 An optical isolator shall comply with UL 1577 if it is relied upon to provide isolation between:

a) Primary and secondary circuits;

b) Extra low-voltage safety circuits; or

c) Other high-voltage circuits.

37.1.1 In addition to complying with 37.1, an optical isolator relied upon to provide feedback between primary and secondary circuits of a switch mode power supply unit shall have a minimum isolation voltage of 1500 V.

37.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1557. If the switching semiconductor is used as part of a switch mode power supply unit, it shall have a minimum isolation voltage of 1500V.

38 Outlet Boxes, Fittings and Cover Plates

38.1 An outlet box shall comply with UL 514A, for metallic outlet boxes or UL 514C, for nonmetallic outlet boxes, flush device boxes, and covers. A fitting shall comply with UL 514B. A cover plate shall comply with UL 514D.

39 Power Supplies

39.1 A power supply shall comply with one of the following:

a) For a Class 2 Power Supply, UL 1310 or UL 60950-1, and with the Class 2 or limited power source requirements.

b) For a power supply that is other than Class 2, UL 1012 or UL 60950-1; or

c) For a switch mode power supply unit not complying with (a) or (b), the relevant requirements in this Standard, including the Switch Mode Power Supply Units – Overload Test, Section 66A, shall be applied.

39.2 *Deleted*

40 Solar Photovoltaic (PV) Systems

40.1 Solar photovoltaic (PV) modules or PV cells on a vending machine shall comply with UL 1703.

40.2 A charge controller, inverter, converter or other components intended for use as part of the PV system shall comply with UL 1741.

40.3 A vending machine with PV modules or cells shall be provided with a factory installed ground-fault circuit-interrupter (GFCI) that complies with UL 943. If the vending machine is:

a) Cord-connected, the GFCI shall comply with 16.1.5 and 16.1.6;

b) Intended for permanent connection to the source of electrical supply or is a stand-alone solar PV system, the GFCI shall be in the circuit supplying power from the PV modules or cells and shall:

1) Automatically disconnect the ungrounded conductors of the faulted circuit; or

2) Enable the inverter or charge controller fed by the faulted circuit to automatically cease supplying power to the output circuits.

40.4 A vending machine with a solar PV system shall be provided with overcurrent protection in the circuit supplying power from the PV modules or cells. The overcurrent protective device size shall not exceed 125 percent of the inverter output current.

40.5 A means shall be provided to disconnect all ungrounded conductors of a solar PV power source and any additional source, such as batteries, from all other conductors within the vending machine. The disconnecting means shall be readily accessible and provided with the marking in 80.2.13.

40.6 In reference to 40.5, manual operation of the main PV disconnect shall not activate the GFCI or result in grounded conductors becoming ungrounded.

40.7 A vending machine with an interactive solar PV system shall be provided with a:

a) Dedicated and marked field wiring termination means of connection. This means shall include the branch circuit overcurrent protective device as required by 40.4;

b) Means to disconnect and isolate the inverter from all other circuitry within the equipment; and

c) Secondary, independent means of controlling the battery charging process when the utility is not present or when the primary charge controller fails or is disabled.

40.8 A vending machine that includes batteries for a solar PV system shall not have more than twenty-four 2 volt cells connected in series (48 volts nominal).

40.9 When a solar PV system on a vending machine includes batteries, overcurrent protection shall be installed in each battery circuit. The protection shall be accessible and be located adjacent to or near the batteries.

40.10 In reference to 40.9, the battery overcurrent protection shall not exceed 125 percent of the total battery output current.

40.11 Charging circuits used with PV supplies shall comply with 39.1.

41 Information Technology Equipment

41.1 Information technology equipment such as a printer, visual display unit, router, communication connectors/data ports or computer shall comply with UL 60950-1.

42 Terminal Blocks

42.1 Terminal blocks shall comply with UL 1059, and, if applicable, be suitably rated for field wiring.

42.2 In reference to 42.1, if a fabricated part performs the function of a terminal block, the part shall comply with the requirements in Terminals, Section 17.3.2, Current-Carrying Parts, Section 18, Insulating Material, Section 19, and the spacings requirements as applicable to the type of circuit as specified below:

a) High-Voltage Circuits, Section 46.1; or

b) Low-Voltage Circuits, Section 46.2.

42.3 If a fabricated terminal block complies with the alternate spacings requirements in Alternate Spacings – Clearances and Creepage Distances, Section 46.3, but not with the spacings requirements in High-Voltage Circuits, Section 46.1, the terminal block shall not be used for field wiring.

43 Transformers

43.1 A transformer (including an autotransformer), shall comply with UL 5085-1 in conjunction with UL 5085-2 or UL 5085-3.

44 Wireways, Auxiliary Gutters and Associated Fittings

44.1 Wireways, auxiliary gutters and associated fittings shall comply with UL 870.

45 Secondary Circuits

45.1 A secondary circuit shall be judged under the applicable requirements in this standard.

Exception No. 1: A circuit supplied by the secondary winding of a transformer that complies with the requirements for a Class 2 transformer need not be investigated.

Exception No. 2: A circuit supplied by a single source consisting of an isolating transformer with an open circuit potential of 30 volts rms (42.4 volts peak) or less need not be investigated from the point at which the current and voltage are limited if the combination of the transformer and a fixed impedance or regulating network complies with the performance requirements for a Class 2 transformer or a secondary circuit fuse having a maximum current rating as specified in Table 45.1 is provided.

Table 45.1
Rating of fuse or circuit protector

Open-circuit volts (peak)	Rating, amperes
0 – 21.2	5.0
21.3 – 42.4	3.2

45.2 With reference to Exception No. 2 to 45.1, if an interchangeable fuse – a fuse is interchangeable if any fuse of a higher ampere rating will fit the fuseholder – is used, a legible and permanent marking shall be provided next to the fuseholder indicating the ampere rating of the fuse to be used for replacement. See 81.6.

46 Spacings

46.1 High-voltage circuits

46.1.1 The following electrical spacing requirements apply to high-voltage circuits as defined in 5.16.

46.1.2 Unless specifically noted otherwise, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall be not less than the values indicated in Table 46.1.

Table 46.1
Electrical spacings in air-handling compartments

Ratings		Minimum spacing					
Volt-amperes	Volts	Through air[a]		Over surface[a]		To enclosure[c]	
		Inch	(mm)	Inch	(mm)	Inch	(mm)
2000 or less	300 or less	1/8[b]	(3.2)	1/4	(6.4)	1/4	(6.4)
	301–600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)
More than 2000	150 or less	1/8[b]	(3.2)	1/4	(6.4)	1/2	(12.7)
	151–300	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
	301–600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)

[a] At points other than field-wiring terminals, the spacings for heater elements only may be as indicated below provided the elements are not subject to moisture, such as may result from condensation on cooled surfaces:

1/16 inch (1.6 mm) Through Air and Over Surface for heaters rated 0–300 volts.

1/4 inch (6.4 mm) Through Air and Over Surface for heaters rated 301–600 volts.

[b] The spacings between wiring terminals of opposite polarity or between a wiring terminal and ground shall be not less than 1/4 inch (6.4 mm), except that if short-circuiting or grounding of such terminals will not result from projecting strands of wire, spacing need not be greater than 1/8 inch (3.2 mm). Wiring terminals are those connected in the field and not factory wired.

[c] Includes fittings for conduit or metal-clad cable.

46.1.3 The ″Through Air″ and ″Over Surface″ spacings given in Tables 46.1 and 46.2 at an individual component part are to be based on the total volt-ampere consumption of the load or loads which the component controls. For example, the spacings at a component which controls only a motor are based on the volt-amperes of the motor. The spacings at a component which controls loads in addition to a motor are based on the sum of the volt-amperes of the loads so controlled, except that spacings at a component which independently controls separate loads are based on the volt-amperes of the larger load. The volt-ampere values for the loads referred to above are to be determined by the marked rating of the loads, except that for loads which are not required to have a marked rating, the measured inputs are to be used in determining the volt-ampere values.

46.1.4 With reference to 46.1.2 and 46.1.3, the spacings to enclosure are not to be applied to an individual enclosure of a component part within an outer enclosure or cabinet.

46.1.5 The spacings indicated in Table 46.2 are applicable only to electrical components mounted in totally enclosed nonair handling compartments which are free of moisture, including that caused by condensation. At wiring terminals and for circuits over 250 volts or over 2000 volt-amperes, spacings in Table 46.1 apply.

Table 46.2
Spacings in non-air handling compartments

Ratings		Minimum spacing in inches (mm)					
Volt-amperes	Volts	Through air		Over surface		To enclosure[a]	
		Inch	(mm)	Inch	(mm)	Inch	(mm)
0 – 2000	0 – 125	1/16	(1.6 mm)	1/16	(1.6 mm)	1/4	(6.4 mm)
	125 – 250	3/32	(2.4 mm)	3/32	(2.4 mm)	1/4	(6.4 mm)

NOTE – See 46.1.5.

[a] Includes fittings for conduit or metal-clad cable.

46.1.6 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity in accordance with the requirements indicated above and shall be judged on the basis of the highest voltage involved.

46.1.7 The above spacing requirements do not apply to the inherent spacings of a component part of the equipment, such as a motor, snap switch, controller, attachment-plug cap, and the like, for which spacing requirements are given in a standard for the component. However, the electrical clearance resulting from the assembly of a component into the complete machine, including clearance to dead metal or enclosures, shall be as indicated herein.

46.1.8 An insulating liner or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be no less than 0.028 inch (0.7 mm) thick and shall be so located or of such material that it will not be adversely affected by arcing.

Exception No. 1: Fiber no less than 0.013 inch (0.3 mm) thick may be used in conjunction with an air spacing of no less than 50 percent of the spacing required for air alone.

Exception No. 2: Material having a lesser thickness may be used if it has equivalent insulating, mechanical, and flammability properties when compared with materials in thicknesses specified above.

46.1.9 If higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system shall be employed in applying the spacings indicated in this section.

Exception: If the developed steady-state potential as determined in the Temperature and Pressure Test exceeds 500 volts, the developed potential is to be used in determining spacings for the parts affected.

46.1.10 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part or enclosure shall be not less than 1/2 inch (12.7 mm) if the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

46.2 Low-voltage circuits

46.2.1 The following electrical spacing requirements apply to low-voltage circuits a defined in 5.21.

46.2.2 A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

46.2.3 The spacings for low-voltage electrical components which are installed in a circuit which includes a pressure-limiting device, motor overload protective device, or other protective device, where a short or grounded circuit may result in unsafe operation of the equipment shall comply with the following:

a) The spacing between an uninsulated live part and the wall of a metal enclosure, including fittings for the connection of conduit or metal-clad cable, shall be not less than 1/8 inch (3.2 mm).

b) The spacing between wiring terminals, regardless of polarity, and between the wiring terminal and a dead metal part, including the enclosure and fittings for the connection of conduit, which may be grounded when the device is installed, shall be not less than 1/4 inch (6.4 mm).

c) The spacing between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part, other than the enclosure, which may be grounded when the device is installed, shall be not less than 1/32 inch (0.8 mm) provided that the construction of the parts is such that spacings will be maintained.

46.2.4 The spacings in low-voltage circuits which do not contain devices such as indicated in the previous paragraph are not specified.

46.3 Alternate spacings – clearances and creepage distances

46.3.1 Other than as indicated in 46.3.2, the spacings requirements in UL 840, are applicable as an alternative to the specified spacings requirements in the following:

a) High-Voltage Circuits, Section 46.1; and

b) Low-Voltage Circuits, Section 46.2.

46.3.2 The spacing requirements in UL 840, shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure.

46.3.3 The items specified in (a) – (f) shall be considered when evaluating a vending machine to the requirements in UL 840:

a) Hermetically sealed or encapsulated enclosures are identified as pollution degree 1.

b) Coated printed wiring boards are identified as pollution degree 1 if they comply with one of the following:

1) The Printed Wiring Board Coating Performance Test in UL 840; or

2) Conformal coating requirements as outlined in UL 746E.

c) Indoor use vending machines are identified as pollution degree 2.

d) Outdoor use vending machines are identified as pollution degree 3.

e) Category II is the overvoltage category.

f) Printed wiring boards are considered as having a minimum comparative tracking index (CTI) of 100 unless further investigated for a higher CTI index.

46.3.4 Clearance B (Controlled Overvoltage) clearances as specified in UL 840, shall be achieved by providing an overvoltage device or system as an integral part of the vending machine.

47 Grounding

47.1 A vending machine shall have provision for the grounding of all exposed dead metal parts that may become energized.

47.2 Except as specified in 47.3 and 47.4, all exposed dead metal parts and all dead metal parts within the enclosure that are exposed to contact by the user, route person, or service person and that may become energized shall be reliably connected to one of the following:

a) The equipment-grounding terminal or lead of a:

1) Permanently installed vending machine; or

2) Vending machine with a stand-alone solar PV system.

b) The equipment-grounding conductor of the cord of a cord-connected vending machine.

47.3 In reference to 47.2(a)(2), a vending machine with a stand-alone solar PV system shall have provision for permanent connection to a grounding means and the equipment grounding connection requirements in 17.2 – 17.4 shall be applied except that the vending machine is not required to have a permanent connection to a grounding means or an equipment grounding connection if the vending machine is marked as specified in 80.2.18.

47.4 Metal parts that do not comply with 47.2 shall be one of the following:

a) An adhesive-attached metal-foil marking, a screw, a handle, and the like, on the outside of an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized;

b) An isolated metal part, such as a magnet frame and an armature, small assembly screws, and the like, that are positively separated from wiring and uninsulated live parts;

c) A panel or a cover that does not enclose an uninsulated live part if wiring is positively separated from the panel or cover so that it is not likely to become energized; and

d) A panel or a cover that is insulated from electrical components, including wiring, by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 1/32 inch (0.8 mm) thick and reliably secured in place.

47.5 Metal-to-metal hinges may be used as a means for bonding a door for grounding.

47.6 A separate component bonding conductor of adequate size shall be copper, copper alloy, or other material acceptable for use as an electrical conductor.

47.7 A separate bonding conductor or strap shall be protected from mechanical damage or be located within the outer enclosure or frame, and not be secured by a removable fastener used for a purpose in addition to bonding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

47.8 Bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point higher than 454°C (850°F). The bonding connection shall reliably penetrate nonconductive coatings such as paint or vitreous enamel. Bonding around a resilient mount shall not depend upon the clamping action of rubber or similar material.

Exception: A connection depending on the clamping action exerted by rubber or a similar material may be acceptable if it complies with the requirements in 60.1 under any degree of compression permitted by a variable clamping device and if the results are still acceptable after exposure to the effects of oil, grease, moisture, and thermal degradation likely to occur in service.

47.9 A clamping device is to be considered with particular emphasis on the likelihood of the device being reassembled in its intended fashion in testing the effect of assembling and disassembling the vending machine for maintenance purposes.

47.10 If the adequacy of a bonding connection cannot be determined by examination, its acceptability shall be determined by the test described in 63.1.

47.11 In a cord-connected vending machine, the cross-sectional area of a bonding conductor or strap shall not be less than that of the grounding conductor of the supply cord.

47.12 The size of a conductor or strap employed to bond an electrical enclosure or a motor frame for a:

a) Permanently connected vending machine shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected.

b) Stand-alone solar PV system vending machine having provision for a permanent connection to a grounding means, shall be based on the rating of the overcurrent protective device required in accordance with 40.4.

47.13 Except as specified in 47.14, the size of the bonding conductor or strap required by 47.12 shall not be less than the applicable value stated in Table 47.1.

47.14 A bonding conductor or strap not complying with 47.12 or 47.13 shall:

a) Comply with the Bonding Connection Test, Section 63; or

b) Not be smaller than the conductors supplying power to the component or components within the vending machine enclosure.

47.15 In reference to 47.14(a), if the Bonding Connection Test, Section 63 is conducted, the components to be tested shall include any connections that may be provided as part of the bonding conductor or strap.

47.16 If more than one rating of branch-circuit overcurrent-protective device is involved, the size of the bonding conductor shall be based on the rating of the overcurrent-protective device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a motor is individually protected by a branch-circuit overcurrent-protective device of lesser rating than other overcurrent-protective devices used with the vending machine, a bonding conductor for that motor is sized on the basis of the device intended for ground-fault protection of the motor.

Table 47.1
Minimum acceptable size of bonding conductor

Rating of overcurrent device, amperes[a]	Size of bonding conductor[b]	
	Copper wire, AWG	Aluminum wire, AWG
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6

[a] See 47.16.
[b] Or equivalent cross-sectional area.

47.17 Functional grounding shall not be relied upon for equipment grounding or bonding.

48 Accessories

48.1 Paragraphs 48.1.1 – 48.6 apply to accessories intended for installation on or connection to a vending machine to modify or supplement the functions of the vending machine or accessory.

48.1.1 A vending machine shall comply with all the requirements of this standard with or without the accessory installed.

48.2 A vending machine having provisions for the use of accessories to be attached in the field shall be so constructed that the use of these accessories will not introduce a risk of fire, electric shock, or injury to persons. See 48.6.

48.3 The installation of an accessory by a route person shall be restricted to an arrangement that can be accomplished by means of a receptacle and plug-in connector.

48.4 The installation of an accessory by a qualified person is acceptable if connections are made to existing terminals by use of wire connectors.

48.5 The installation of an accessory shall not require the field rearrangement of components or wiring, the cutting or splicing of wiring, or the soldering of connections.

48.5.1 An accessory strain-relief means shall be provided for the wiring if there is a possibility of transmitting stress to the terminal connections during installation. The strain-relief shall comply with the Strain Relief Test, Section 68.

48.5.2 Unless correct connections are evident, the wiring connections for the accessory shall be identified on both the accessory and on the vending machine.

48.5.3 The accessory mounting location shall be:

a) Identified on the vending machine; or

b) Fixed due to the function of the accessory and its arrangement within the vending machine. In this case, the accessory installation instructions shall specify the mounting location of the accessory.

48.5.4 Accessories intended for connection to a source of field power supply independent of that of the vending machine shall comply with the requirements in:

a) Section 16 if intended to be a cord-connected accessory.

b) Section 17if intended to be a permanently connected accessory. A permanently connected accessory shall not be used with any supply cord connected equipment.

48.6 As part of the investigation, an accessory shall be tested and trial installed to determine that its installation is feasible, that the instructions are detailed and correct, and that the use of the accessory does not introduce a risk of fire, electric shock, or injury to persons. See 80.4.2.

49 Coin and Credit Mechanisms

49.1 A coin or credit mechanism shall be acceptable for the temperatures involved and for controlling the connected load or loads. The mechanism shall be installed in the vending machine at the factory.

Exception: A coin or credit mechanism may be installed in the field, if the mechanism and vending machine comply with the requirements in 49.2 – 49.5 and 80.2.8, 81.4, and 81.5.

49.2 The installation of a coin or credit mechanism shall be by means of receptacles and plug-in connectors. Unless bonding for grounding is accomplished automatically by normal mounting of the mechanism in the vending machine, a separate bonding conductor shall be provided in the receptacle and plug-in connector.

49.3 A strain-relief means shall be provided for the wiring in the mechanism if there is a possibility of transmitting stress to the terminal connections during installation.

49.4 A coin or credit mechanism shall be trial-installed to determine that its installation is feasible and that the instructions are detailed and correct. A risk of electric shock shall not be present during installation of a mechanism unless the marking required by 81.4 is provided. Following installation, the use of a mechanism shall not result in a risk of fire, electric shock, or injury to persons.

49.5 A vending machine without a coin or credit mechanism shall be evaluated for the accessibility of live or moving parts capable of causing injury to persons without a mechanism installed and with the enclosure of the vending machine open to the extent permitted by the absence of the coin or credit mechanism.

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PROTECTION AGAINST INJURY TO PERSONS

50 General

50.1 General

50.1.1 If the intended operation of a vending machine involves a risk of injury to persons, protection shall be provided to reduce such a risk.

50.1.2 The details of guards, safety releases, pressure relief valves, interlocks, or the like, are not specified, but the need for such devices and the adequacy of any such device provided are to be determined from a study of the complete vending machine, its operating characteristics, and the likelihood of injury to persons resulting from other than gross negligence.

50.1.3 With reference to the requirement in 50.1.2, the degree of protection required of the enclosure depends upon the general construction and intended use of the vending machine. The factors to be taken into consideration in judging the acceptability of exposed moving parts are:

a) The degree of exposure;

b) The sharpness of the moving parts;

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

d) The speed of movement of those parts; and

e) The likelihood of fingers, arms, hair, or clothing being drawn into the moving parts, such as at points where gears mesh or where belts travel onto a pulley or where moving parts close in a pinching or shearing action.

50.1.4 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 during intended maintenance or use.

50.1.5 Coin return and vending machine discharge openings, including those portions of vending machine discharge chutes that might be accessible to the user, are to be evaluated to determine compliance with 50.1.1.

50.2 Switches and controllers

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

50.2.2 The requirement in 50.2.1 may necessitate the use of an interlock in the vending machine if moving parts or the like may result in a risk of injury to persons upon the automatic restarting of the motor.

50.3 Lids

50.3.1 A lid that may cause injury upon unintentional closing shall be:

a) Counterweighted;

b) Spring-loaded; or

c) Provided with an automatic latch to retain it in the open position. The action members of the latches shall be enclosed or guarded.

51 Stability Test

51.1 A vending machine shall be stable and shall not overturn when subjected to the tests described in 51.2.

51.2 A free-standing vending machine is to be supported by the legs, leveling screws, or casters provided in the base of the vending machine. Other means of support, such as wall brackets, plumbing connections, or conduit connections, are not to be relied on for the purpose of the tests except that a door support that complies with the requirements in 51.3 can be used for the test described in (b). The vending machine is to be tested as follows:

a) An empty vending machine, with service doors, covers, and panels closed, is to be placed on a plane surface inclined at an angle of 10 degrees from the horizontal. Accessories that are intended for use with the vending machine are to be installed. Swivel-type casters, if any, are to be oriented so that the tendency to overturn is maximum.

b) An empty vending machine with accessories installed is to be placed on a horizontal surface. If leveling screws are provided, they are to be adjusted equally to raise the vending machine 1 inch (25.4 mm) above floor level. If swivel-type casters are provided, they are to be oriented so that the tendency to overturn is maximum. A force of 35 pounds (156 N) is to be applied vertically downward at the edge of the main service door farthest from the hinges, with the door opened at an angle of 90 degrees from the cabinet. If it is necessary to open more than one door to gain access to the vending machine storage compartment, all such doors are to be opened. Any subassembly, such as a cup dispenser, that swings out of the cabinet for servicing is to be positioned so that the tendency of the vending machine to overturn is maximum. If more than one such subassembly is provided, the one that provides the most severe unbalanced condition is used during the test.

51.3 If required for compliance with 51.2(b), a leg, a brace, or a similar support provided in the vending machine door shall be fixed in position or shall operate automatically to position itself when the door is opened, and shall be constructed so that its intended function cannot be readily defeated. See the marking requirements in 81.3.

51.4 The manufacturer's instructions are to be used to install the vending machine for tests to determine compliance with the requirements in 51.3. All adjustments of door support means are to be made in accordance with the directions included with the vending machine. After the initial installation procedure is completed, no further adjustments are to be made.

51.5 A unique mounting or support system that requires securing a vending machine to a wall or other support surface is to be separately evaluated to determine its reliability, ease of operation, and likelihood of continued use.

52 Risk of Injury to Servicemen

52.1 If an uninsulated live part of a vending machine that presents a risk of electric shock is made accessible by opening or removing a cover, door, panel, or other closure inside the vending machine to afford a service person access to internal components for mechanical servicing such as pushing a reset button, oiling, and the like, it shall be provided with a guard over the live part to prevent a service person from unintentionally touching it. See 52.2 and 52.3.

52.2 An appropriate guard shall be provided over a part that is in motion during servicing and that presents a risk of injury to persons such as pinching, snagging, cutting, or the like to the service person or route person when a cover, door, panel, or other closure is opened or removed.

52.3 A guard that must be removed during servicing of a part as specified in 52.1 or 52.2 shall be constructed and arranged so it can be removed and replaced with a minimum of effort.

53 Pressure Vessels and Parts Subject to Pressure

53.1 If the operation of a vending machine involves the generation and confining under pressure of steam or other gas, consideration is to be given to the possibility of a risk of explosion incident to such operation. This applies to a vending machine having immersed electrodes, where the electrolysis of water may result in the accumulation of oxygen and hydrogen. A vending machine is not acceptable unless its strength is adequate with respect to any risk of explosion that may be involved.

53.2 Except as noted in 53.3, a pressure vessel having an inside diameter of more than 6 inches (152 mm) and subject to a pressure of more than 15 pounds force psig (103 kPa) shall be certified by the National Board of Boiler and Pressure-Vessel Inspectors. This pressure vessel shall be marked in accordance with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) – H, M, S, or U – for a working pressure not less than the pressure determined by applying 53.4.

53.3 If a pressure vessel is not covered under the inspection procedures of the ASME Code because of its application, it shall be constructed so that it will comply with the requirement in 53.4(c).

53.4 Except as noted in 53.5 and 53.6, a part 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 without rupture a pressure equal to the highest of the following that is applicable:

a) Five times the pressure corresponding to the maximum setting of an acceptable pressure-reducing valve provided as part of the assembly – but not more than five times the marked maximum supply pressure from an external source – and not more than five times the pressure setting of a pressure-relief device provided as part of the assembly;

b) Five times the marked maximum supply pressure from an external source, except as provided in (a);

c) Five times the pressure setting of a pressure-relief device provided as part of the assembly;

d) Five times the maximum pressure that can be developed by an air compressor that is part of the assembly, unless the pressure is limited by a pressure-relief device in accordance with (a); or

e) Five times the working pressure marked on the part.

53.5 A test need not be conducted to determine whether a part complies with the requirement in 53.4 if study and analysis indicate that the strength of the part is adequate for the purpose as a result of its material and dimensions. For example, copper or steel pipe of standard size and provided with standard fittings might be considered to have adequate strength.

53.6 A pressure vessel bearing the ASME code inspection symbol – H, M, S, or U – is considered to comply with the requirement in 53.4 if the vessel is marked with a value of working pressure not less than it is subject to during normal or abnormal operation.

53.7 If a test is necessary to determine whether a part complies with the requirement in 53.4, two samples of the part are to be subjected to a hydrostatic-pressure test. Each sample is to be filled with water so as to exclude air and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value and is to be held at that value for 1 minute. The results are not acceptable if either sample ruptures or leaks.

Exception: Leakage at a gasket during the hydrostatic-pressure test is acceptable if it occurs at a pressure of more than 40 percent of the required test value.

54 Pressure-Relief Devices

54.1 A means for safely relieving pressure shall be provided for all parts in which pressure might be generated in the event of fire.

54.2 Pressure-relief devices – see 54.3 – fusible plugs, soldered joints, nonmetallic tubing, or equivalent pressure-relief means may be employed to comply with the requirements in 54.1.

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

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

54.5 A vessel having an inside diameter of more than 3 inches (76.2 mm) and subject to air or steam pressure generated or stored within the vending machine shall be protected by a pressure-relief device.

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

54.7 A pressure-relief device:

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

b) Shall be installed so that it is readily accessible for inspection and repair and cannot be readily rendered inoperative; and

c) Shall have its discharge opening located and directed so that the risk of scalding is not likely to occur; and operation of the device will not deposit moisture on bare live parts or on insulation or components detrimentally affected by moisture.

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

54.9 If a pressure relief device is required, the pressure-limiting control responsible for limiting the pressure in the vessel shall comply with 26.8(b) and 26.14. It shall also prevent the pressure from exceeding 90 percent of the relief device setting under any condition of normal operation.

PERFORMANCE

55 General

55.1 Except as specified in 55.2, during any test in which temperatures are measured, temperatures shall be monitored until maximum temperatures are attained. Thermal equilibrium is to be considered to exist when three successive readings indicate the same or decreasing temperatures. Readings shall be taken at the end of not less than three consecutive periods, the duration of each period being not less than 5 minutes.

55.2 In reference to 55.1, if temperatures on the component being monitored cycle between higher and lower temperatures due to the component cycling as part of the test (for example a load cycling on and off due to operation of a protective device), equilibrium is to be considered obtained when three successive peak temperatures indicate the same or decreasing temperatures.

55.3 In reference to 55.1 and 55.2, the recorded temperature shall be the highest of the three readings.

56 Leakage Current Test

56.1 A cord-connected, single phase vending machine shall be subjected to a leakage current test in accordance with:

a) 56.1.1 – 56.10 if the vending machine is rated for a nominal 250-volt or less supply; or

b) UL 101, if the vending machine is rated for a nominal 120 volt supply and employs a standard attachment-plug rated 15 or 20 amperes.

c) *Deleted*.

56.1.1 In reference to 56.1(a) and the measurement circuits in Figure 56.1, the leakage current shall not exceed any of the following:

a) 0.75 milliampere:

1) as measured on ungrounded accessible surfaces if the grounding conductor is connected and switch S1 is closed; or,

2) as measured on dead metal parts in areas of a hot drink vending machine that are accessible to contact during the vending operation if both the grounding conductor and switch S1 are open;

b) 1.0 milliampere if the grounding conductor is open (disconnected) and switch S1 is closed or with the grounding conductor connected and switch S1 is opened;

c) 2.0 milliamperes if the grounding conductor is open and switch S1 is open; and

d) 3.5 milliamperes for any vending machine having a grounding conductor detector-interrupter that de-energizes the vending machine if the connection opens between the accessible conductive parts of the vending machine and the service equipment ground.

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

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56.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered acceptable for protection against electric shock as specified in Accessibility of Live Parts, Section 14. Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to present a risk of electric shock.

56.4 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 metal foil with an area of 10 by 20 centimeters in contact with the surface. Where 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 vending machine.

56.5 The measurement circuit for leakage current is to be as shown in Figure 56.1. 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 of 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 microfarad.

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 kilohertz, 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 0.75 milliamperes, the measurement is to have an error of not more than 5 percent.

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

56.7 A sample vending machine is to be prepared and conditioned 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 the production unit.

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

c) The sample is to be conditioned in an ambient temperature of 21 – 27°C (70 – 80°F) and 50 percent ±5 percent relative humidity for not less than 8 hours.

d) The test is to be conducted at the ambient conditions specified in (c).

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

f) A vending machine that requires connection to a potable water supply is to be filled with water.

56.8 The test sample is to be installed so that all parallel ground paths, such as through the fill and drain lines, will be eliminated.

56.9 The leakage current test sequence, with reference to the measuring circuit, Figure 56.1, is to be as follows:

a) With switch S1 open, the vending machine is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2. All manual switching devices are to be operated in their normal manner, and leakage currents are to be measured using both positions of switch S2.

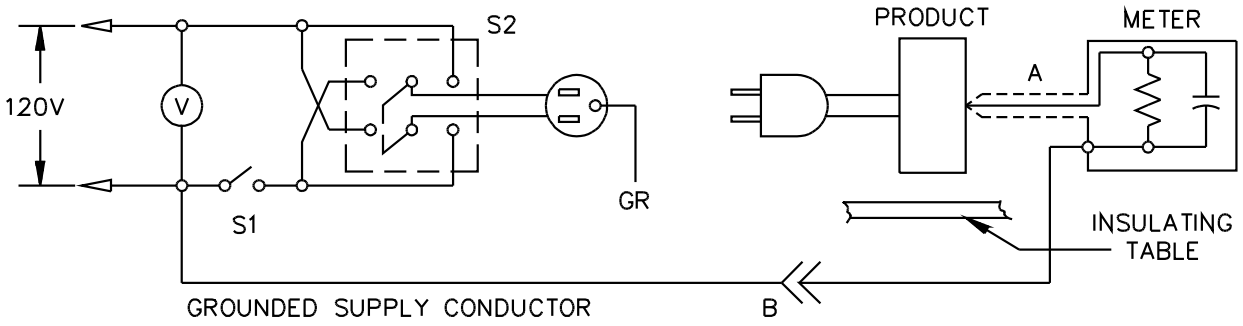
b) With the vending machine switching devices in their normal operating positions, switch S1 is to be closed, energizing the vending machine, and within 5 seconds the leakage current is to be measured using both positions of switch S2. All manual switching devices are then to be operated in their normal manner, and leakage currents are to be measured using both positions of switch S2.

c) The vending machine manual switching devices are then to be returned to their normal operating positions and the vending machine allowed to run until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test, thermal equilibrium is defined as the condition in which leakage current is found to be constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement. Thermal equilibrium may involve cycling caused by an automatic control in the heating and vending mode. This cycling is to be observed with switch S2 in both positions.

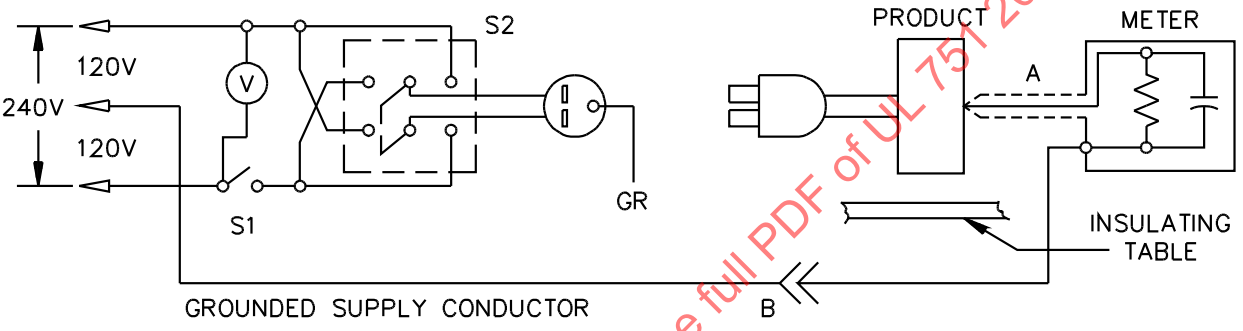
d) If the vending machine employs a single-pole switch, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the vending machine is turned off.

56.10 Normally the complete leakage current test program as covered in 56.9 is conducted without interruption for other tests. With the concurrence of those concerned, the leakage current tests may be interrupted to conduct other nondestructive tests.

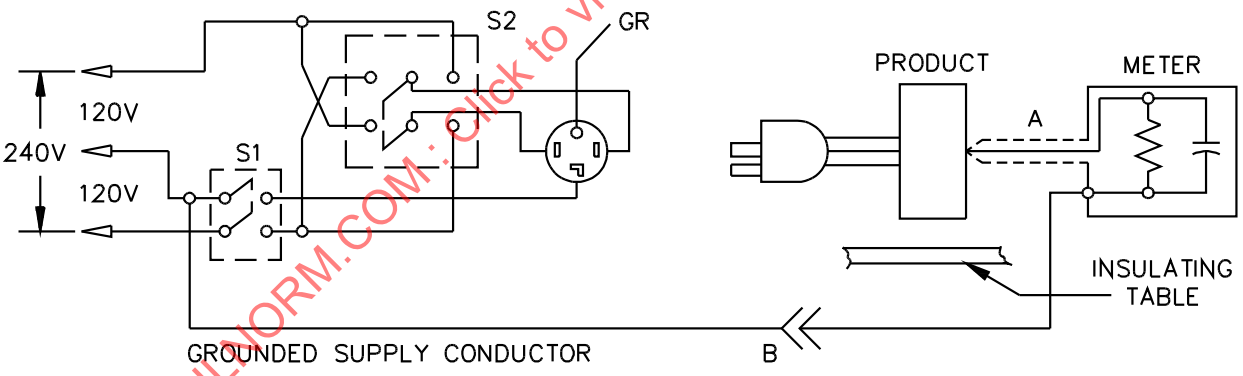
Figure 56.1
Leakage current measurement circuits



Product intended for connection to a 120–volt power supply, as illustrated above.



Product intended for connection to a 3–wire, grounded neutral power supply, as illustrated above.



Product intended for connection to a 3–wire, grounded neutral power supply, as illustrated above.

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NOTES –

A: Probe with shielded lead.

B: Separated and used as clip when measuring currents from one part of product to another.

57 Input Test

57.1 The current input to a vending machine shall not be greater than 110 percent of the rated value when the vending machine is operated under the condition of maximum normal load as described in Temperature Test, Section 58 when connected to a supply circuit of maximum rated voltage and rated frequency.

Exception: For a battery-operated vending machine, the input is to be measured with the vending machine in the charging mode during the Temperature Test, Section 55, after operating for five minutes. The battery is to be fully discharged in accordance with the battery manufacturer's instructions at the start of the test.

57.2 With reference to 57.1, the maximum rated voltage is to be as specified in 58.1.6.

57.3 If a user accessible 15 or 20 ampere receptacle is provided on a vending machine, the vending machine measured ampere input shall be increased by an amount equal to 80 percent of the receptacle rating.

57.4 If a receptacle is not user accessible, but is accessible to a route or service person, the measured ampere input shall be increased by an amount equal to the watt or ampere rating marked on the vending machine in accordance with 80.2.7.

58 Temperature Test

58.1 General

58.1.1 When tested under the conditions of maximum normal load as described in 58.2.1 – 58.2.3, a vending machine shall not attain a temperature at any point sufficiently high to constitute a risk of fire, to adversely affect any materials employed in the vending machine, or to exceed the temperature rises specified in Table 58.1.

58.1.2 A thermal- or overcurrent-protective device shall not open the circuit during intended use of the vending machine.

58.1.3 Coil and winding temperatures are to be measured by thermocouples located on exposed surfaces except the resistance method may be used for a coil that is inaccessible for mounting of these devices such as a coil:

a) Immersed in sealing compound;

b) Wrapped with thermal insulation such as asbestos; or

c) Wrapped with more than two layers of material such as cotton, paper, or rayon more than 1/32 inch (0.8 mm) thick. In an alternating-current motor having a diameter of 7 inches (178 mm) or less, the thermocouple is to be mounted on the integrally-applied insulation of the coil wire.

Table 58.1
Maximum acceptable temperature rises

	Materials and components	°C	(°F)
1	Varnished cloth insulation	60	108
2	Fuses	65	117
3	Fiber employed as electrical insulation	65	117
4	Wood and other combustible material	65	117
5	Any point within a terminal box or wiring compartment of a permanently connected vending machine in which power supply conductors are to be connected, including such conductors themselves, unless the vending machine is marked in accordance with 80.3.2.	35	63
6	A surface upon which a permanently wired vending machine might be mounted in service, and surfaces that might be adjacent to the vending machine when it is mounted.	65	117
7.	Insulation systems on coil windings of an a-c motor having a frame diameter of more than 7 inches (178 mm), of a d-c motor, and of a universal motor.[b]		
	A. Class A insulation system:		
	1. In an open motor		
	Thermocouple method	65[a]	117[a]
	Resistance method	75	135
	2. In a totally enclosed motor		
	Thermocouple method	70	126
	Resistance method	80	144
	B. Class B insulation system:		
	1. In an open motor		
	Thermocouple method	85[a]	153[a]
	Resistance method	95	171
	2. In a totally enclosed motor		
	Thermocouple method	90	162
	Resistance method	100	180
8.	Insulation systems on coil windings of an a-c motor having a frame diameter of 7 inches (178 mm) or less – not including a universal motor – and on a vibrator coil.		
	A. Class A insulation system:		
	1. In an open motor and on a vibrator coil		
	Thermocouple or resistance method	75[a]	135[a]
	2. In a totally enclosed motor		
	Thermocouple or resistance method	80	144
	B. Class B insulation system:		
	1. In an open motor and on a vibrator coil		
	Thermocouple or resistance method	95[a]	171[a]
	2. In a totally enclosed motor		
	Thermocouple or resistance method	100	180
9.	Insulation systems on windings of a relay, a solenoid, a magnet, and the like[b]		
	A. Class 105 insulation system:		
	Thermocouple method	65[a]	117[a]
	Resistance method	85	153
	B. Class 130 insulation system:		
	Thermocouple method	85	153
	Resistance method	105	189
10.	Phenolic composition employed as electrical insulation or as a part the deterioration of which would result in a risk of fire or electric shock	125[b]	225
11.	Rubber- or thermoplastic-insulated wire and cord	35[c,d]	63
12.	On the surface of a capacitor casing:		
	Electrolytic	40[e]	72

Table 58.1 Continued on Next Page

Table 58.1 Continued

Materials and components	°C	(°F)
Other types	65[f]	117
13. Transformer with Class 105 insulation systems:		
Thermocouple method	65[b]	117
Resistance method	75[b]	135
14. External surface subject to contact in normal use:[g]		
A. Metallic	35	63
B. Nonmetallic	60	108

[a] 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 be higher by the following amount that the maximum indicated:

Item	Subitem	Additional Temperature Rise	
7	A1	15°C	27°F
7	B1	20°C	36°F
8	A1	5°C	9°F
8	B1	10°C	18°F
9	A	15°C	27°F

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

[b] See 58.1.3 and General, Section 55.

[c] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and found to have heat-resistant properties.

[d] Rubber-insulated conductors within a Class A insulated motor, rubber-insulated motor leads, and a rubber-insulted flexible cord entering a motor can be subjected to a temperature rise more than 35°C (63°F) if a braid is employed on the conductor of other than a flexible cord. However, this does not apply to thermoplastic-insulated wires or cords.

[e] For an electrolytic capacitor that is integral with or attached to a motor the temperature rise on insulating material integral with the capacitor enclosure is not to exceed 65°C (117°F).

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

[g] If the function of an appliance precludes limiting the temperature of a surface to the values specified, the surface shall be guarded or enclosed to prevent unintentional contact. See 12.1 – 12.6.

58.1.4 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2). However, when referee temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type indicating instrument are to be used.

58.1.5 A short length of rubber- or thermoplastic-insulated flexible cord exposed to a temperature higher than 60°C (140°F), such as at terminals, is acceptable if supplementary heat-resistant insulation of adequate dielectric strength is employed on the individual conductors of the cord to prevent deterioration of the conductor insulation. This supplementary insulation should not extend outside of the vending machine nor into the strain relief clamp.

58.1.6 For the temperature test, the vending machine is to be connected to a source of supply of maximum rated voltage except that the voltage is to be 120 volts for a vending machine rated between 110 and 120 volts and is to be 240 volts for a vending machine rated between 220 and 240 volts.

58.2 Maximum normal load

58.2.1 Maximum normal load is considered to be the load that approximates as closely as possible the most severe conditions of intended use. It is not a deliberate overload except as the conditions of actual use can be more severe than the maximum load conditions that are recommended by the manufacturer of the vending machine. Tests that have been found to be close approximations of the most severe conditions of intended use are described in 58.2.3 for some common products. However, vending machines having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements.

58.2.2 The test is to be conducted simulating the most severe installation the construction permits. Installation in an alcove, in a right-angle corner of a room, or against a wall is to be simulated if the vending machine lends itself to such placement.

58.2.3 A vending machine is to be operated under standby conditions until temperatures become constant. Following this the vending machine is to be operated vending products – in a sequence of vends intended to allow all ingredients to be exhausted at the same time– at the maximum possible rate, or 6 cycles of operation per minute, whichever is less. Operation is to be continued in this manner under the conditions noted below. A sold-out condition is then to be simulated and operation continued until temperatures become constant:

a) A hot-drink vending machine with a capacity of 500 or less cups is to be operated for a total of 200 vends.

b) A hot-drink vending machine with a capacity of more than 500 cups is to be operated for a total of 400 vends.

c) A hot-food vending machine with a capacity of 300 items or less is to be operated for a total of 100 vends.

d) A hot-food vending machine with a capacity of more than 300 items is to be operated for a total of 200 vends.

e) A cigarette, candy, or the like vending machine is to be operated for a total of 100 vends.

59 Dielectric Voltage-Withstand Test

59.1 A vending machine shall withstand, without breakdown, a test potential applied for 1 minute between line-voltage live parts and dead metal parts and between live parts of high and low voltage circuits. The test potential shall be 1000 V plus twice rated voltage at any frequency between 40 and 70 hertz.

Exception No. 1: The test potential for units rated at not more than 1/2 horsepower (373 watts output) shall be 1000 V.

Exception No. 2: If the steady-state voltage developed in a motor circuit through the use of capacitors exceeds 500 V, as measured during the temperature test, the test potential for the parts affected shall be 1000 V plus twice the developed capacitor voltage.

Exception No. 3: If agreeable to all parties concerned, the test potential may be a direct-current (dc) potential as specified in Table 77.1, Condition A and applied for 1 minute.

59.2 Equipment using a low-voltage circuit shall withstand, without breakdown, the specified test potential applied for 1 min between low-voltage live parts and dead metal parts. The test potential shall be:

a) A dc potential of 700 V; or

b) An ac potential of 500 V at any frequency between 40 and 70 Hz.

59.3 In reference to 59.2, if components specified in 46.2.3 are employed in the low-voltage circuit:

a) The dielectric voltage-withstand test shall be conducted on the components with the dielectric potential applied between live parts of opposite polarity; or

b) The components shall be separately subjected to the dielectric voltage-withstand test.

59.4 With reference to 59.3, the test between low-voltage parts of opposite polarity shall be conducted on magnet coil windings of the transformer after breaking the inner coil lead where it enters the layer.

59.5 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with the previous paragraphs. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at the value for 1 minute.

Exception: The requirement of a 500 volt-ampere or larger transformer can be waived if the high potential testing equipment maintains the specified high potential voltage at the equipment during the duration of the test.

59.6 If the charging current through a capacitor or capacitor-type filter connected across the line, or from line to earth ground, is large enough to make it impossible to maintain the required alternating-current test potential, the capacitors and capacitor-type filters may be tested as described in the next paragraph.

59.7 The capacitors and capacitor-type filters mentioned in the previous paragraph are to be subjected to a direct-current test potential of 1414 volts for equipment rated 250 volts or less or 1414 volts plus 2.828 times the rated circuit voltage for equipment rated at more than 250 volts. The direct-current test potential is to be maintained for 1 minute without breakdown. Components providing a d.c. path in parallel with the insulation to be tested, such as discharge resistors for filter capacitors and voltage limiting devices (transient voltage suppressors), may be disconnected during the test.

60 Abnormal Operation Test

60.1 When a vending machine is operated continuously under abnormal conditions that are likely to occur, there shall not be a risk of fire or electric shock due to emission of flame or molten metal other than drops of melted solder, or glowing or flaming of flammable material upon which the vending machine may be placed or, for a permanently installed vending machine, flammable material that may be in proximity to the vending machine as installed. A 3-ampere fuse connected between the frame and ground shall not open.

60.2 After having been subjected to an abnormal test, a cord-connected vending machine is considered to present a risk of electric shock if the insulation resistance is less than 50,000 ohms.

60.3 To determine whether a risk of fire or electric shock exists, a separate burnout or abnormal test is to be conducted with the vending machine operating continuously until the ultimate result has been determined. The test is to be conducted with the applied voltage and method of mounting, in accordance with 58.1.6 and 58.2.2. In most cases, continuous operation for 7 to 8 hours will be necessary in order to determine whether the ultimate result has been observed. A cord-connected vending machine is to be placed on white tissue paper on a softwood surface.

61 Resistance to Moisture Tests

61.1 Humidity

61.1.1 A vending machine employing insulating material likely to be adversely affected by moisture under conditions of intended use is to be exposed for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (90 ±4°F). After the conditioning:

a) A cord-connected vending machine rated 250 volts or less shall comply with the requirements in 56.1 in a repeated leakage current test, except that the test is to be discontinued when leakage current stabilizes.

b) The insulation resistance of a vending machine other than as mentioned in (a) shall not be less than 50,000 ohms between live parts and interconnected dead metal parts.

61.1.2 Ordinarily, insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms and using a 250-volt direct-current circuit.

61.2 Water spray

61.2.1 After the water spray test described in 61.2.3 and 61.2.4, a vending machine intended for outdoor use or use in a protected location shall:

a) For a vending machine as specified in 56.1, comply with the requirements in 56.1 in a repeated leakage current test, except that the test is to be discontinued when leakage current stabilizes.

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

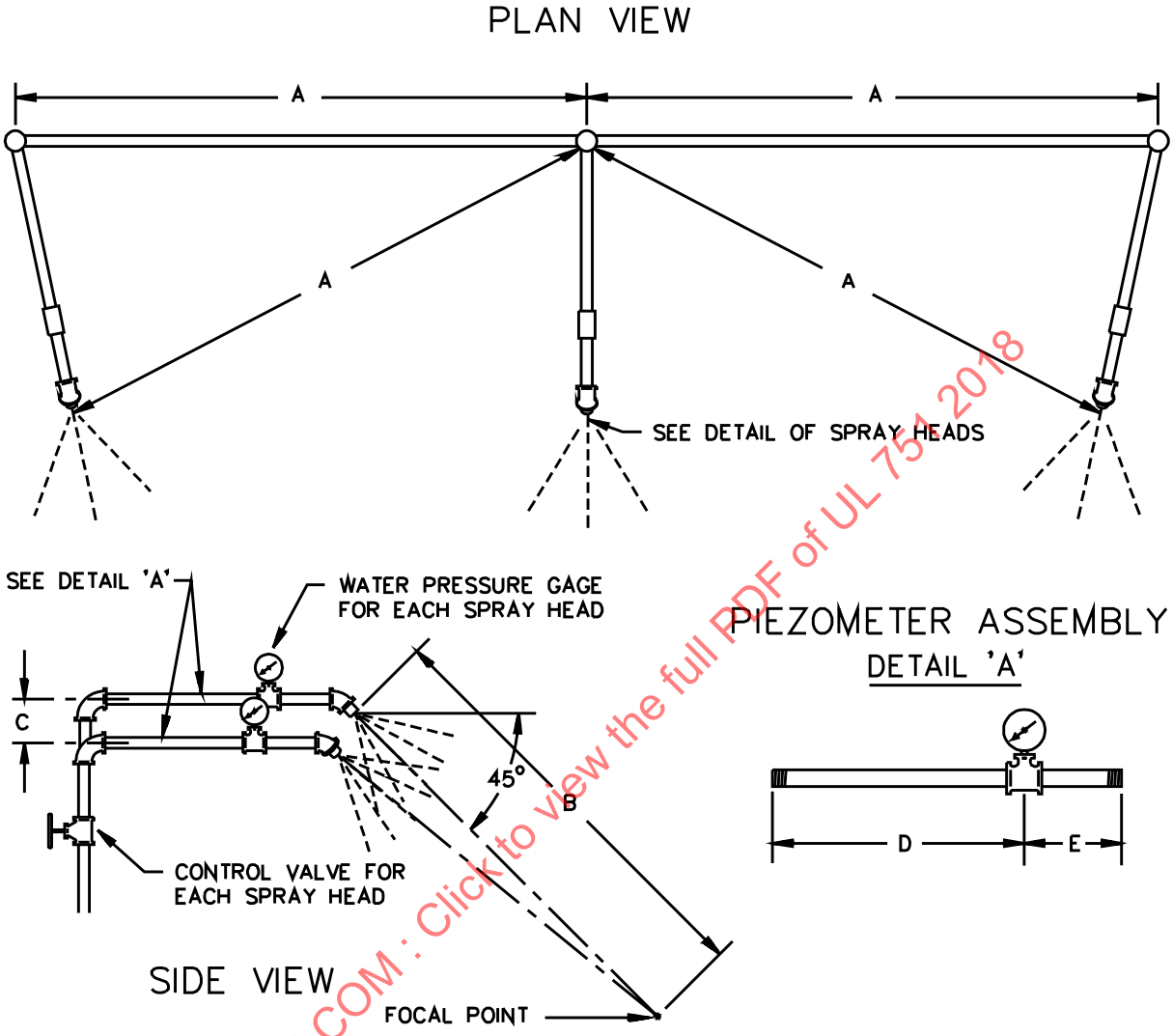
c) Withstand without breakdown for 1 minute the dielectric voltage-withstand test described in 59.1 between live parts and interconnected dead metal parts.

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

61.2.3 The vending machine is to be positioned and leveled in accordance with the manufacturer's instructions. A vending machine intended for use in a protected location is to be provided with a representative shelter, such as a roof, canopy, marquee, or the like, which is to be positioned over the vending machine, in accordance with the manufacturer's instructions. A vending machine intended for outdoor use is tested without a shelter. Following the water spray, the insulation resistance and leakage current are to be measured, and then the vending machine is to be tested for dielectric voltage-withstand in accordance with 59.1.

61.2.4 The water spray apparatus is to consist of three spray heads constructed in accordance with the details illustrated in Figure 61.1 and mounted in a water supply pipe rack as illustrated in Figure 61.2. The water pressure for all tests is to be maintained at 5 psi (34 kPa) at each spray head. The distance between the center nozzle and the vending machine is to be approximately 5 feet (1.5 m). The vending machine is to be brought into the focal area of the three spray heads in such a position and under such conditions as are most likely to result in entrance of water into the vending machine. The spray is to be directed at a 45-degree angle to the vertical toward the vending machine. The total exposure is to be for 1 hour.

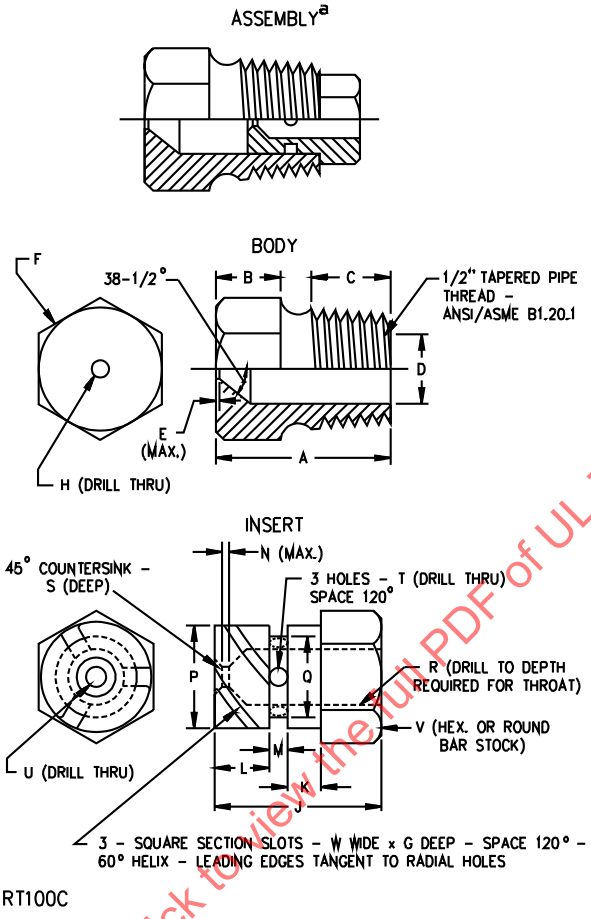
Figure 61.1
Spray-head assembly



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

RT101D

Figure 61.2
Spray-head pipe rack



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.79
H	(No. 9)[b]	5.0	U	(No. 40)[b]	2.49
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Molded nylon Rain-Test Spray Heads are available from Underwriters Laboratories, Inc.
[b] ANSI/ASME B94.11 Drill Size.
[c] Optional – To serve as wrench grip.

62 Thermostat Tests

62.1 A thermostat employed for regulating or limiting the temperature shall be tested as specified in Table 62.1.

62.2 With reference to Table 62.1:

a) A temperature-regulating thermostat is considered to be one that functions only to regulate the temperature of the vending machine under intended conditions of use, so that its breakdown would not result in a risk of fire.

b) A temperature-limiting thermostat is considered to be one that functions only under conditions that produce abnormal temperatures. The breakdown of such a thermostat might result in a risk of fire.

c) A combination temperature-regulating and -limiting thermostat is considered to be one that functions to regulate the temperature of the vending machine under intended conditions of use, and also serves to prevent a risk of fire that might result from conditions of abnormal operation.

62.3 If a thermostat is used in conjunction with a magnetic contactor or other auxiliary equipment, the tests mentioned in 62.1 and 62.4 are to be conducted on the combination of thermostat and contactor functioning as a unit.

62.4 Under the provisions of 62.1 – 62.3, it will usually be necessary to retest a thermostat or other control device that has previously been investigated separately and subjected to an endurance test involving an appreciably smaller number of cycles than would be represented by the normal life of the vending machine.

Table 62.1
Number of cycles of operation for thermostats

Type of thermostat[a]	Automatically reset thermostat	Manually reset thermostat
Temperature-regulating	A number of cycles equivalent to 1000 hours of intended operation of the vending machine, but not less than 30,000 cycles. However, the test may be omitted if, with the thermostat short-circuited, no temperature higher than the limits specified in Table 58.1 are attained in a normal temperature test of the vending machine.	To be made the subject of an investigation. No operating value is specified because of the unlikely use of this type of thermostat.
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the appliance under any condition that causes the thermostat to function.[b]	100 cycles under load and 5000 cycles without load.[b]
Combination temperature-limiting and -regulating	100,000 cycles if, with the thermostat short-circuited, there is evidence of a risk of fire as described in 60.1. If there is no evidence of a risk of fire under this condition, the thermostat is to be tested as described above for a temperature-regulating thermostat.	To be made the subject of an investigation. No operating value is specified because of the unlikely use of this type of thermostat.

[a] See 62.2.

[b] The test may be omitted if, with the thermostat short-circuited, there is no evidence of a risk of fire as described in 60.1 during continuous abnormal operation of the vending machine.

63 Bonding Connection Test

63.1 A bonding connection is acceptable – see 47.10 – if the connection does not open when carrying twice the current equal to the rating of the branch-circuit overcurrent-protective device for 2 minutes.

64 Metallic Coating Thickness Test

64.1 When tested as described in 64.2 – 64.9, the metallic coating thickness shall comply with the requirements in 15.5 and 15.6.

64.2 The solution to be used for the metallic coating thickness test is to be made from distilled water and is to contain 200 grams per liter of reagent grade chromic acid (CrO_3) and 50 grams per liter of reagent grade concentrated sulphuric acid (H_2SO_4). The latter is equivalent to 27 milliliters per liter of reagent grade concentrated sulphuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

64.3 The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of 0.025 inch (0.64 mm) and a length of 5.5 inches (140 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that when the stopcock is open the rate of dropping is 100 ±5 drops per minute. If needed, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

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

64.5 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be completely removed by means of a solvent. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care should be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

64.6 After cleaning, the sample to be tested is to be supported 0.7 to 1.0 inch (17.8 to 25.4 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested should be inclined approximately 45 degrees from the horizontal.

64.7 With the sample to be tested in place under the orifice, the stopcock is to be opened and the time in seconds is to be measured with a stopwatch until the dropping solution dissolves the protective metal coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by a change in color.

64.8 Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface and at an equal number of points on the outside surface, at places where the metal coating may be expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation are likely to have thin coatings.

64.9 To calculate the thickness of the coating being tested, select from Table 64.1 the thickness factor appropriate for the temperature at which the test was conducted and multiply by the time in seconds required to expose base metal as noted in 64.7.

Table 64.1
Coating thickness factors

Temperature, degrees		Thickness factors, 0.00001 inches (0.0003 mm) per second	
F	(C)	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

65 Overload of Motor Switches or Controllers Test

65.1 In reference to 26.2(a), a switch or other device that controls 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. There shall be no electrical or mechanical breakdown of the device or undue pitting or burning of the contacts as a result of the overload test and the fuse in the grounding connection shall not open.

65.2 In a test to determine whether a switch or other control device complies with the requirement in 65.1, the vending machine is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage – see 58.1.6 – with the rotor of the motor locked in position. During the test, exposed dead metal parts of the vending machine are to be connected to ground through a 3-ampere plug fuse, and the connection is to be such that any single pole, current-interrupting device will be located in the ungrounded conductor of the supply circuit. If the vending machine is intended for use on direct current, or on direct current as well as alternating current, exposed dead metal parts of the vending machine are to be connected to be positive with respect to a single-pole, current-interrupting, control device. The device is to be operated at a rate of not more than 10 cycles per minute except that a faster rate of operation may be employed if agreeable to those concerned.

66 Overload and Endurance Test – Switching Devices

66.1 This test applies to switches or other similar control devices as specified in 26.2 (b) and (c).

66.2 A switching device in a vending machine shall perform acceptably when tested as specified in 66.3 – 66.8 for overload and endurance. There shall be no electrical or mechanical failure nor undue burning, pitting or welding of contacts, or striking of an arc to dead metal parts.

66.3 The tests on switching devices shall be conducted by:

a) Evaluating the control devices within a vending machine by operating the vending, coin, credit or other similar mechanisms in accordance with 66.4 and 66.6, using the normal switching device loads of the vender; or

b) Cycling the switching devices individually or collectively while controlling the loads specified in 66.5 – 66.7.

66.4 If the test in 66.3(a) is conducted, the:

a) Enclosure of the vending machine shall be connected through a 30 ampere cartridge fuse to the electrical test circuit pole considered least likely to strike (arc) to ground;

b) Switching device shall be mounted as intended in service; and

c) Test cycling shall be as specified in 66.6 unless a slower rate is required by the design of the vending machine. A faster rate may be used if agreeable to all concerned.

66.5 If the test in 66.3(b) is conducted, the switching device shall be subjected to an overload test at the ambient temperature for which it is intended. The overload test shall consist of making and breaking the connected load for 50 cycles of operation, with 1 second ON and 9 seconds OFF. The current, power factor and voltage used for testing each type of load shall be as follows:

a) Noninductive load(s) – 150 percent of the total connected load current. The power factor shall be 1.0 and the voltage shall be as specified in 58.1.6.

b) One or more motors together with one or more other loads – 100 percent of the locked-rotor current of the largest motor plus 100 percent of the full load current of all other motors and/or other loads. The power factor shall be 0.4 – 0.5 and the voltage shall be as specified in 58.1.6.

c) One or more inductive loads, such as a transformer or ballast, with or without other noninductive or pilot duty loads – 100 percent of the total inductive and other noninductive/pilot duty loads. The power factor shall be 0.7 – 0.8 and the voltage shall be as specified in 58.1.6.

d) One or more pilot duty loads, such as coils within a relay or electric valve – 100 percent of the total connected pilot duty loads. The power factor shall not exceed 0.35 and the voltage shall be 110 percent of the value specified in 58.1.6.

66.6 A switching device shall be subjected to an endurance test at the ambient temperature for which it is intended. The endurance test shall consist of making and breaking the connected load for 6000 cycles of operation, with 1 second ON and 9 seconds OFF. The voltage shall be as specified in 58.1.6. The current shall be 100 percent of the total connected load current.

66.7 For a switching device tested in accordance with 66.3(b), the power factor for the endurance cycling specified in 66.6 shall be as specified in 66.5 for each type of load.

66.8 At the conclusion of the test in 66.3, each switching device shall be subjected to the Dielectric Voltage-Withstand Test, Section 59.

66A Switch Mode Power Supply Units – Overload Test

66A.1 The test applies to switch mode power supply units as specified in 39.1(c).

66A.2 Each output winding, or section of a tapped winding, is overloaded in turn, one at a time, while the other windings are kept loaded or unloaded, whichever load conditions of normal use is the least favorable.

66A.3 Overloading is carried out by connecting a variable resistor (or an electronic load) across the power supply output. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 minute to maintain the applicable overload. No further readjustments are then permitted.

66A.4 For this test, any protective devices such as a fuse, manual reset circuit protector, thermal protector, etc. are allowed to remain in the circuit.

66A.5 If overcurrent protection is provided by an overcurrent protection device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 hr. If this value cannot be derived from the specification, it is to be established by test.

66A.6 If no overcurrent protection is provided, the maximum overload is the maximum power output obtainable from the power supply.

66A.7 In case of voltage foldback, the overload is to be slowly increased to the point which causes the output voltage to collapse. The overload is then established at the point where the output voltage recovered and held for the duration of the test.

66A.8 The duration of the test is to be for 7 hours or until ultimate results are reached. At the conclusion of the test, there shall be no charring or burning of electrical insulation, no opening of any protective device or any circuit component.

67 Flexing of Internal Wiring

67.1 The wiring from the vending machine to components mounted on the door is to be tested by opening the door as far as possible – restraints such as chains are to remain in place – and then closing it for 6,000 cycles of operation. Following this test, the vending machine shall comply with the dielectric voltage-withstand test described in 56.1. The wiring is then to be examined for damage.

68 Strain Relief Test

68.1 When a vending machine is tested in accordance with 68.1 – 68.5, there shall be no movement of the cord or wiring leads, to indicate that stress is transmitted to internal connections and wiring.

68.2 A strain relief means for a power supply cord, including that for an externally-mounted accessory shall be subjected to a direct pull of 35 pounds-force (156 N). The force may be generated by suspending a 35 pound (15.9 kg) weight on the cord of the vending machine.

68.3 A strain relief means for wiring leads intended for connection of field-installed supply conductors and power supply conductors of an internally-mounted accessory shall be subjected to a direct pull of 20 pounds-force (89 N). The force may be generated by suspending a 20 pound (9.1 kg) weight on the vending machine leads.

68.4 The force specified in 68.2 or 68.3 shall be applied so that the strain relief is stressed from any angle permitted by the construction of the vending machine.

68.5 The force shall be applied for not less than 1 minute.

69 Push-Back Strain-Relief Test

69.1 To determine compliance with 16.2.2, a vending machine shall be tested in accordance with 69.2 without occurrence of any of the conditions specified in 16.2.2(a) – (d).

69.2 The attached flexible cord is to be held 1 in (25.4 mm) from the point where the cord emerges from the enclosure of the vending machine and is then to be pushed back into the machine. The cord is to be pushed back into the vending machine in 1 in (25.4 mm) increments until the cord buckles or the force to push the cord into the vending machine is greater than 6 lbf (26.7 N). The cord within the vending machine is to be manipulated to determine compliance.

Exception No. 1: When an integral cord guard is provided, the push-back force is to be applied 1 in (25.4 mm) from the end of the cord guard.

Exception No. 2: For constructions where the enclosure is provided with an open air discharge or similar structure that is located adjacent to, or encompasses the cord exit location, the push-back force is to be applied 1 in (25.4 mm) from the point where the cord emerges from the junction box or other wiring compartment.

70 Glass Strength Test

70.1 Impact test

70.1.1 One sample of exterior glass as specified in 12.8 shall be subjected to the test described in 70.1.2. As a result of the test, the sample shall withstand the specified impact without cracking or breaking to the extent that the pieces are released or dropped from their intended position.

Exception: The test is not required for exterior glass of a nonshattering or tempered type that, when broken, complies with ANSI Z97.1.

70.1.2 The sample is to be subjected to a 2-1/2 ft-lbf (3.4 J) impact from a 2-in (50.8-mm) diameter, 1.18-lb (0.54-kg) steel ball. The steel ball is to impact the sample by falling vertically or swinging as a pendulum. The ball is to impact the sample within 1 in (25.4 mm) of the center of the glass area.

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