UL 541

STANDARD FOR SAFETY

Refrigerated Vending Machines

UL Standard for Safety for Refrigerated Vending Machines, UL 541

Ninth Edition, Dated April 21, 2016

Summary Of Topics

This revision to ANSI/UL 541 dated November 19, 2020 revises installation instructions for vending machines having flammable refrigerant; SA6.2.3.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated October 16, 2020.

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The most recent designation of ANSI/UL 541 as an American National Standard (ANSI) occurred on November 19, 2020. 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, refrigerated vending machines intended for connection to alternating-current circuits rated 600 volts or less in accordance with ANSI/NFPA 70. Vending machines covered by these requirements:

a) Incorporate refrigeration systems of the air-cooled or water-cooled type employing hermetic refrigerant motor-compressors;

b) May be battery operated;

c) May employ flammable refrigerant as defined in Requirements for Refrigerated Venders Employing a Flammable Refrigerant in the Refrigerating System, Supplement SA;

d) May employ thermoelectric chilling systems.

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

1.3 These requirements do not cover vending machines incorporating universal motors rated at more than 250 volts, nor vending machines which have a principal function other than storage and dispensing of refrigerated products; nor to vending stations, that is, freestanding stationary structures for outdoor use.

2 Units of measurement

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

3 Terminology

3.1 The term "product," as used in this standard, refers to the refrigerated product as stored or dispensed by the vender.

3.2 The term "vender," as used in this standard, and as defined in 5.40, refers to a refrigerated vending machine or part thereof covered by this standard unless specifically noted otherwise.

4 References

4.1 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*

ASHRAE Standards

ASHRAE 15, *Refrigeration Systems*

ASHRAE 34, *Designation and Safety Classification of Refrigerants*

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 D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension*

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

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

ASTM E659, *Test Method for Autoignition Temperature of Liquid Chemicals*

ASTM E681, *Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*

IEC Standards

IEC 60079-11, *Explosive Atmospheres – Part 11: Equipment Protection By Intrinsic Safety "i"*

IEC 60079-15:2010, *Explosive Atmospheres – Part 15: Equipment Protection By Type Of Protection "n"*

IEC 60079-20-1, *The Explosive Atmospheres – Part 20-1: Material Characteristics for Gas and Vapour Classification – Test Methods and Data*

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 60529, *Degrees of Protection Provided by Enclosures (IP Code)*

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*

ISA Standards

ISA 12.12.01:2015, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*

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*

NFPA HAZ01, *Fire Protection Guide to Hazardous Materials*

SAE Standards

SAE J513, *Refrigeration Tube Fittings – General Specifications*

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 207, *Refrigerant-Containing Components and Accessories, Nonelectrical*

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 248-15, *Low-Voltage Fuses – Part 15: Class T Fuses*

UL 252, *Compressed Gas Regulators*

UL 310, *Electrical Quick-Connect Terminals*

UL 340, *Comparative Flammability of Liquids*

UL 429, *Electrically-Operated Valves*

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 542, *Fluorescent Lamp Starters*

UL 635, *Insulating Bushings*

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 935, *Fluorescent-Lamp Ballasts*

UL 943, *Ground Fault Circuit Interrupters*

UL 969, *Marking and Labeling Systems*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

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 2182, *Refrigerants*

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 60079-11-2013, *Explosive Atmospheres – Part 11: Equipment Protection By Intrinsic Safety "i"*

UL 60079-15, *Explosive Atmospheres – Part 15: Equipment Protection By Type Of Protection "n"*

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

UL 60335-2-34, *Safety of Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors*

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*

5 Glossary

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

5.2 ACCESSORY – A device or component intended for installation in or connection to a vender 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 vender for electrical power, signaling, switching, or the like.

5.3 ADJUSTABLE SPEED DRIVE – A combination of power converter, inverter, motor, and motor-mounted auxiliary devices such as encoders, tachometers, thermal switches and detectors, air blowers, heaters, and vibration sensors.

5.4 ADJUSTABLE SPEED DRIVE SYSTEM – An interconnected combination of equipment that provides a means of adjusting the speed of a mechanical load coupled to a motor. A drive system typically consists of an adjustable speed drive and auxiliary electrical apparatus.

5.5 AUTOMATIC VENDER – A vender which delivers a product electromechanically by the use of motors or solenoids or both.

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

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

5.7.1 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.)

5.8 CAPILLARY TUBE – Device made of tubing with an outer diameter of less than 3/16 in. (4.7 mm) and used to reduce the pressure of the refrigerant between the condenser and evaporator. It also regulates the refrigerant flow.

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

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

5.11 COMPONENT – A device or fabricated part of the vender covered by the scope of a safety standard dedicated to that purpose. If incorporated in a vender, 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.

5.12 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 potential risk of fire, electric shock, or injury to persons 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 fire, electrical shock, or injury to persons.

5.13 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. 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 fire, electrical shock, or injury to persons. Such functions may also be known as "safety critical."

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

5.15 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.

5.16 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.

5.17 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.

5.18 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.

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

5.20 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 5.25.

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

5.22 INTENDED LOCATION:

a) INDOOR – Located inside a building and consequently not subjected to the effects of weathering.

b) PROTECTED – Located in an area which is partially protected from the effects of weathering through the use of a roof, canopy, marquee, or the like.

c) OUTDOOR – Located in the open and subjected to the full effects of weathering.

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

5.24 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.

5.25 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.

5.26 MAXIMUM OPERATING CURRENT (MOC) – The current resulting when an electric motor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor/adjustable speed drive or drive system is at a maximum.

5.27 MAXIMUM RATED CURRENT (MRC) – The current resulting when a hermetic refrigerant motor-compressor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor-compressor/adjustable speed drive or drive system is at a maximum.

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

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

5.30 NONAUTOMATIC VENDER – A vender which delivers a product by requiring the customer to operate the vending mechanism by moving a lever, knob, bottle, or the like.

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

5.32 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.

5.32.1 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.

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

5.34 ROUTE PERSON – The person who regularly opens a vender for such purposes as cleaning, inserting/removing currency or coins, replenishing the product supplied, and making minor adjustments.

5.35 SERVICE PERSON – The person who may periodically open a vender to repair or maintain electrical and mechanical components.

5.36 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 vender.

5.37 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.

5.37.1 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.

5.38 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.

5.39 VENDER, THERMOELECTRIC – A refrigerated vender in which the product to be vended is chilled by applying a direct current supply source to a semiconductor thermoelectric module creating a temperature gradient which transfers heat from one surface to another (may also be known as the "Peltier Effect").

5.40 VENDERS (OR REFRIGERATED VENDING MACHINES) – 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. Refrigerated vending machines are self-contained, completely factory-made and factory-tested assemblies to which no refrigerant-containing parts are connected in the field.

5.41 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.

CONSTRUCTION

6 General

6.1 The assembly shall be constructed so that the public, route person, and service person will be protected against unintentional contact with uninsulated live parts. See Electrical Enclosures, 13.3.

6.2 Enclosures for an individual electrical component, or a group of components, outer cabinets, and combinations of the two, are considered in determining compliance with the requirement in 6.1.

6.3 Combustible or electrically conductive thermal insulation shall not contact uninsulated live parts. See Insulation Resistance Test, Section 66.

6.4 Except for mechanical parts which are necessarily exposed during intended operation, the rotors of motors, pulleys, belts, gears, and the like, shall be enclosed or guarded to protect the public, route person, and service person against unintentional contact.

6.5 A vender shall be assembled so that removal and replacement of tanks and containers, replenishment of the product, and the like, will not result in damage to electrical components and wiring, or to refrigerant-containing components.

6.6 Electrical components shall be located or enclosed so that:

a) Liquid due to splashing, leakage, overflow, or condensation will not drain on or be drawn onto uninsulated live parts; and

b) Product materials will not contact uninsulated live parts if spilled.

6.7 If a failure of a liquid container, hose, fitting, or product line provided as part of a vender would result in a risk of electric shock or injury to persons, these components shall be of material which is resistant to corrosion by the liquid intended to be used therein and shall have the necessary strength for the pressures involved. See Strength Tests, Section 83.

6.8 A switch, lampholder, an attachment plug receptacle, a motor attachment plug, or similar component shall be secured in position and shall be prevented from turning. See 6.9.

Exception No. 1: The requirement that a switch be prevented from turning will be waived if all of the following conditions are met:

a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during the operation of the switch.

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

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

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

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

6.9 The means for preventing rotation mentioned in 6.8 shall consist of more than friction between surfaces. A toothed lock washer that provides both spring take-up and an interference lock is acceptable as means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

6.10 An uninsulated current carrying part and a part that supports a live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction in spacings below the minimum acceptable values specified in 50.2.

6.11 Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part but a lock washer as described in 6.9 is acceptable.

6.12 A vender which provide for the storage of carbon dioxide cylinders, or the like, shall be provided with means for retaining the cylinders in position.

6.13 A vender shall be equipped to prevent the dispensing of a free product or coins by rocking or tilting the vender. See Antitheft Device Test, Section 70.

Exception: The test in Wireways, Auxiliary, Gutters and Associated Fittings, Section 46, need not be conducted if the vendor is rigidly secured to a wall, pillar, floor or other permanent part of a building structure.

6.14 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;

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

e) Not contain mercury.

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.

6.15 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.

6.16 Ferrous metal parts shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting if they are used as follows:

a) To support or retain electrical components in position; or

b) Within the bonding or grounding path.

7 Nonmetallic Parts

7.1 All nonmetallic parts, except for small nonfunctional parts shall comply with the requirements in Nonmetallic Materials, Section 8, Nonmetallic Material Ignition Sources Separation, Section 9 and Nonmetallic Material Application and Location, Section 10 and Table 92.1.

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 With 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 92.1.

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:

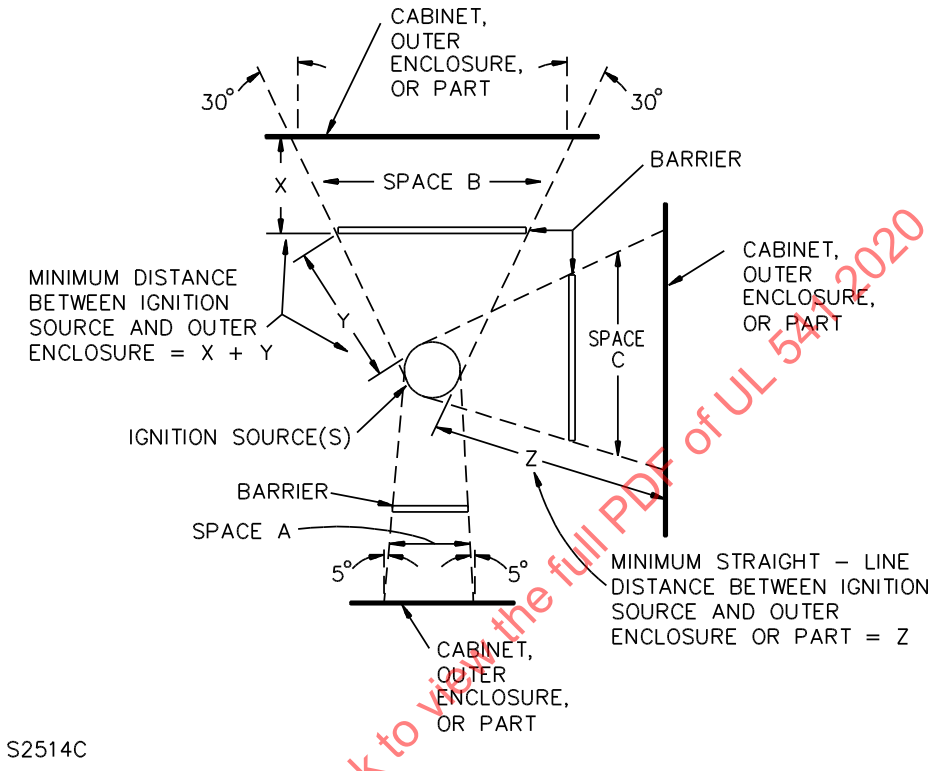
a) Below an ignition source and within Space A of Figure 9.1;

b) Above an ignition source and within Space B of Figure 9.1; and

c) In the vertical plane relative to an ignition source and within Space C of Figure 9.1.

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 90.1.

10.2 Nonmetallic fasteners used as a part of the enclosure shall comply with the requirements in the Fastener Strength Test, Section 93.

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 items (a) to (e).

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

11.3 Except as specified in 16.1.2(d), 27.1 and 50.7 a nonmetallic barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 92.1.

11.4 A nonmetallic barrier providing mechanical protection source (s) shall comply with the cabinet requirements of Table 92.1.

12 Accessories

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

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

12.2 The installation of accessories shall:

a) Be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors; and

b) Not require the cutting of wiring or the soldering of connections.

12.3 A cord-connected accessory, including means for external interconnection between the accessory and vender, shall employ a power-supply cord and strain-relief means in accordance with 15.9 – 15.18.

12.4 Strain relief means shall be provided for the wiring in the accessory if there is a possibility of transmitting strain to the terminal connections during installation.

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

12.4.2 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.

12.4.3 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 14, Supply Connections for Permanently Connected Venders, if intended to be a permanently connected accessory. A permanently connected accessory shall not be used with any supply cord connected equipment;

b) Section 15, Supply Connections for Cord Connected Venders, if intended to be a cord-connected accessory.

12.5 As part of the investigation, accessories are to be trial-installed to determine that their installation is feasible, that the instructions are detailed and correct, and that the use of the accessories does not introduce a risk of electric shock, fire, or injury to persons.

12.6 An accessory shall have provision for the grounding of all exposed or accessible noncurrent-carrying metal parts that may be contacted by the user or by route and service personnel during service operations that are likely to be performed while the accessory is energized.

13 Enclosures

13.1 General

13.1.1 Each enclosures shall be so formed and assembled 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 or injury to persons due to total or partial collapse, with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

13.1.2 An enclosure of sheet metal is evaluated with respect to its size, shape, thickness of metal, and use in a particular application. Sheet steel shall not be less than 0.026 inch (0.66 mm) thick if uncoated, or 0.029 inch (0.74 mm) if galvanized; nonferrous sheet metal shall not be less than 0.036 inch (0.91 mm) thick.

Exception: Relatively small areas or surfaces which are curved or otherwise reinforced may be thinner.

13.1.3 Among the factors which are to be taken into consideration when evaluating an enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability;

e) Resistance to distortion at temperatures to which the material may be subjected under conditions of use; and

f) Resistance to corrosion.

13.1.4 A glass panel used for the enclosure of electrical parts or that is subject to contact during intended use or maintenance of the vendor, or both, shall be supported or secured in place and shall comply with the Glass Strength Test, Section 84.

13.1.5 Exterior glass having an exposed minor dimension greater than 12 in (305 mm) and an area greater than 1 ft^2 (0.093 m^2) shall comply with the Impact Test, Section 84.1.

13.1.6 Exterior glass having an exposed minor dimension greater than 3 in (76 mm) shall comply with the Mechanical Pressure Test, Section 84.2.

13.1.7 Other than as specified in 13.1.8 – 13.1.10, glass that is subject to contact during use and routine maintenance of the vendor shall not have a thickness less than 0.115 in (2.92 mm), and shall comply with Impact Test, Section 84.1 or Mechanical Pressure Test, Section 84.2.

13.1.8 The effects of the following factors shall be considered in the investigation of glass panels and glass components 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.

13.1.9 A glass component, other than a lamp, used inside a vendor shall have smooth edges if the edges are exposed to contact during routine use, including cleaning. Edges 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.

13.1.10 The glass components specified in 13.1.9 shall comply with Glass Component Strength Test, Section 85.

13.2 Protection against corrosion

13.2.1 Steel enclosures shall be protected against corrosion by metallic or nonmetallic coatings as specified in 13.2.2 – 13.2.8.

13.2.2 Venders for protected or outdoor use (see 5.22) shall employ enclosures which prevent the wetting of live parts and reduce the risk of electric shock due to weather exposure. Enclosures for electrical components shall have provision for drainage if knockouts or unthreaded openings are employed in the enclosure. See Rain Test, Section 67.