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.

No Text on This Page

APRIL 21, 2016
(Title Page Reprinted: November 19, 2020)

ANSI/UL 541-2020

UL 541

Standard for Refrigerated Vending Machines

First Edition – August, 1958
Second Edition – February, 1970
Third Edition – March, 1974
Fourth Edition – July, 1979
Fifth Edition – February, 1989
Sixth Edition – July, 1995
Seventh Edition – February, 2010
Eighth Edition – December, 2011

Ninth Edition

April 21, 2016

This ANSI/UL Standard for Safety consists of the Ninth edition including revisions through November 19, 2020.

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.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

ELECTRICAL COMPONENTS

SPACINGS

CARBONATION SYSTEM

PRODUCT LINES

REFRIGERATION SYSTEM

PERFORMANCE

MANUFACTURING AND PRODUCTION TESTS

MARKING

SUPPLEMENT SA – REQUIREMENTS FOR REFRIGERATED VENDERS EMPLOYING A FLAMMABLE REFRIGERANT IN THE REFRIGERATING SYSTEM

SUPPLEMENT SB – REQUIREMENTS FOR REFRIGERATED VENDING MACHINES INTENDED FOR INSTALLATION WITHIN MOTOR FUEL DISPENSING FACILITIES

APPENDIX A Operating and protective ("safety critical") control functions (Normative)

No Text on This Page

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:

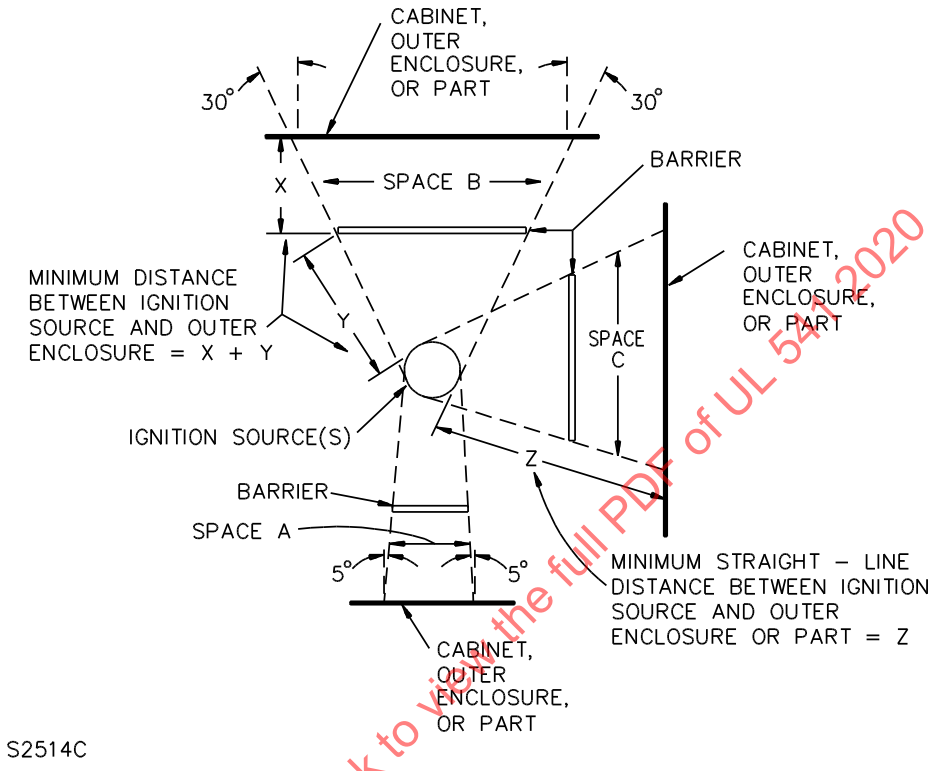
a) Below an ignition source and within Space A of Figure 9.1;

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.

13.2.3 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion by the means indicated in Table 13.1, or by other metallic or nonmetallic coatings which provide equivalent protection.

Exception: The requirement is not applicable to a metal part, such as a decorative grille, which is not required for compliance with this standard.

Table 13.1
Corrosion protection

Type of cabinet and enclosure	No. 16 MSG/GSG and heavier as specified by	Lighter than No. 16 MSG/GSG as specified by
Outer cabinets which protect motors, wiring, or enclosed current carrying parts	13.2.4	13.2.5
Inside enclosures which protect current carrying parts	13.2.4	13.2.5
Outer cabinets which are the sole enclosure of current carrying parts	13.2.5	13.2.5

13.2.4 To comply with the applicable requirement of Table 13.1 one of the following coatings shall be used:

a) Hot-dipped mill galvanized sheet steel conforming with the Coating Designation G60 or A60 in Table 1 of 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 Specification. The weight of zinc coating may be determined by any suitable method; however, in case of question the weight of coating shall be established in accordance with the Test Method of ASTM A90/A90M. An A60 (alloyed) coating shall also comply with 13.2.6.

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 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 90. An annealed coating shall also comply with 13.2.6.

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 may be determined by consideration of its composition or by corrosion tests if these are considered necessary.

13.2.5 To comply with the applicable requirement of Table 13.1, one of the following coatings shall be used:

a) Hot-dipped mill galvanized sheet steel conforming with the Coating Designation G90 in Table 1 of 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 Specification. The weight of zinc coating may be determined by any suitable method; however, 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 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 90. An annealed coating shall also comply with 13.2.6.

c) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of coating is to be established by the Metallic Coating Thickness Test.

d) A zinc coating conforming with 13.2.4 (a) or (b) with one coat of outdoor paint as specified in 13.2.4(c).

e) A cadmium coating not less than 0.00075 inch (0.0191 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0005 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating is to be established by the Metallic Coating Thickness Test and the paint shall be as specified in 13.2.4(c).

13.2.6 An annealed zinc coating which 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.

13.2.7 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 are to conform with 13.2.6.

13.2.8 With reference to 13.2.3, other finishes, including paints, special metallic finishes and combinations of the two may be accepted when comparative tests with galvanized sheet steel without annealing, wiping, or other surface treatment conforming with 13.2.4 (a) or 13.2.5 (a), as applicable, indicate they provide equivalent protection. Among the factors which are taken into consideration when judging such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

13.2.9 Nonferrous enclosures may be employed without special corrosion protection. The thickness of the material is to be judged on the basis of its strength and rigidity.

13.3 Electrical enclosures

13.3.1 Each gasket required to seal an electrical enclosure against the entrance of rain and condensate shall comply with 89.2 – 89.6 or with UL 157 if the gasket physical properties are equivalent to those specified in 89.2 – 89.6. In addition, each gasket shall:

a) Be held in place by mechanical fasteners or adhesives except as specified in 13.3.2;

b) Be neoprene, rubber, or thermoplastic or other materials with equivalent properties.

13.3.2 With reference to 13.3.1 (b), 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.

13.3.3 Adhesives required to secure gaskets shall comply with 89.7.

13.3.4 The frame or chassis of a vender shall not be relied on to carry current during operation.

13.3.5 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) if uncoated steel, not less than 0.034 inch (0.86 mm) if galvanized steel, and not less than 0.045 inch (1.14 mm) if nonferrous.

13.3.6 Electrical components, such as relays, solenoids, and electrically operated valves, shall be individually enclosed, except at terminals, unless it can be determined that failure of the component will not result in a risk of fire. See 6.2 and Burnout Tests – Components, Section 76.

13.3.7 The assembly shall be arranged so that fuses can be replaced and manual-reset devices can be reset without removing parts other than a service cover or panel and without contacting uninsulated live parts. See 13.3.16.

13.3.8 Covers for enclosures of fuses in high-voltage circuits, shall be hinged. Covers for manual-reset overload protective device enclosures shall be hinged if it is necessary to open the cover to reset the device.

Exception: A fuseholder may be installed in a vender without being enclosed if the vender enclosure is complete and nonflammable and contains no flammable material in proximity to or under the fuses.

13.3.9 Hinged covers, where required by 13.3.8, shall not depend solely upon screws or other similar means requiring the use of tools to hold them closed, but shall be provided with a spring latch or catch.

13.3.10 A door or cover giving direct access to fuses in other than low-voltage circuits, shall shut closely against a 1/4 inch (6.4 mm) rabbet, or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A special construction, such as a fuse enclosure, located within an outer enclosure, or a flange and rabbet combination which affords the equivalent protection is acceptable.

13.3.11 Strips used to provide rabbets, or angle strips fastened to the edge of a door, shall be secured at not less than two points, not more than 1-1/2 inches (38 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

13.3.12 The requirements in 13.3.13 – 13.3.15 apply only to parts of high-voltage circuits as defined by 5.25.

13.3.13 Uninsulated live parts of a vender shall be located, guarded, or enclosed so as to prevent accidental contact by persons through openings in the enclosure.

13.3.14 Behind a locked door, an opening:

a) That will not permit entrance of a 3/4 inch (113.1 mm) diameter rod is acceptable if:

1) A probe as illustrated in Figure 13.1 cannot be made to touch any uninsulated live part when inserted through the opening; and

2) A probe as illustrated in Figure 13.2 cannot be made to touch film-coated wire when inserted through the opening.

b) That will permit entrance of a 3/4 inch (113.1 mm) diameter rod is acceptable under the conditions described in Figure 13.3.

Figure 13.1

Probe

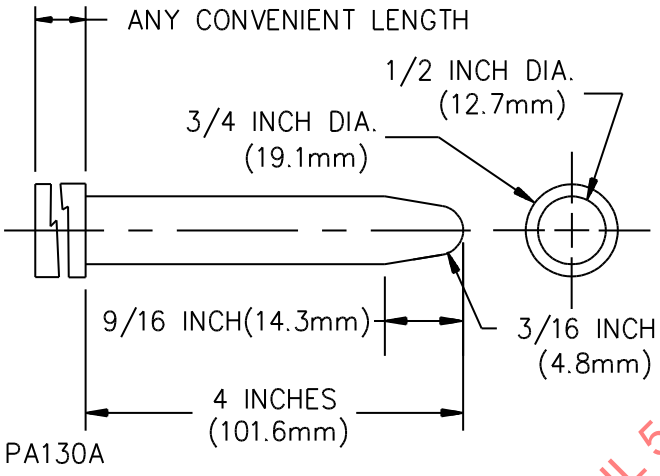


Figure 13.2

Probe

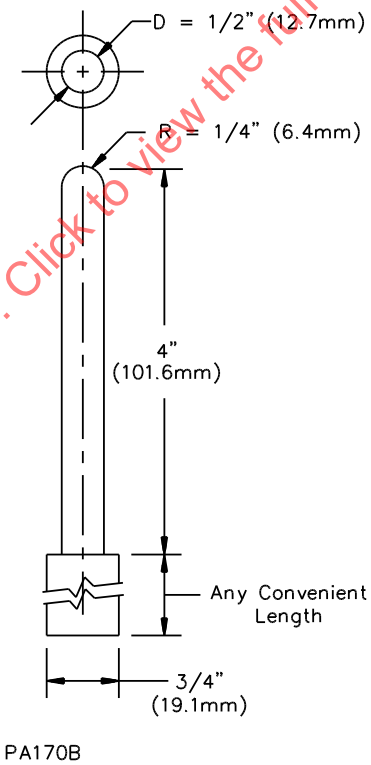
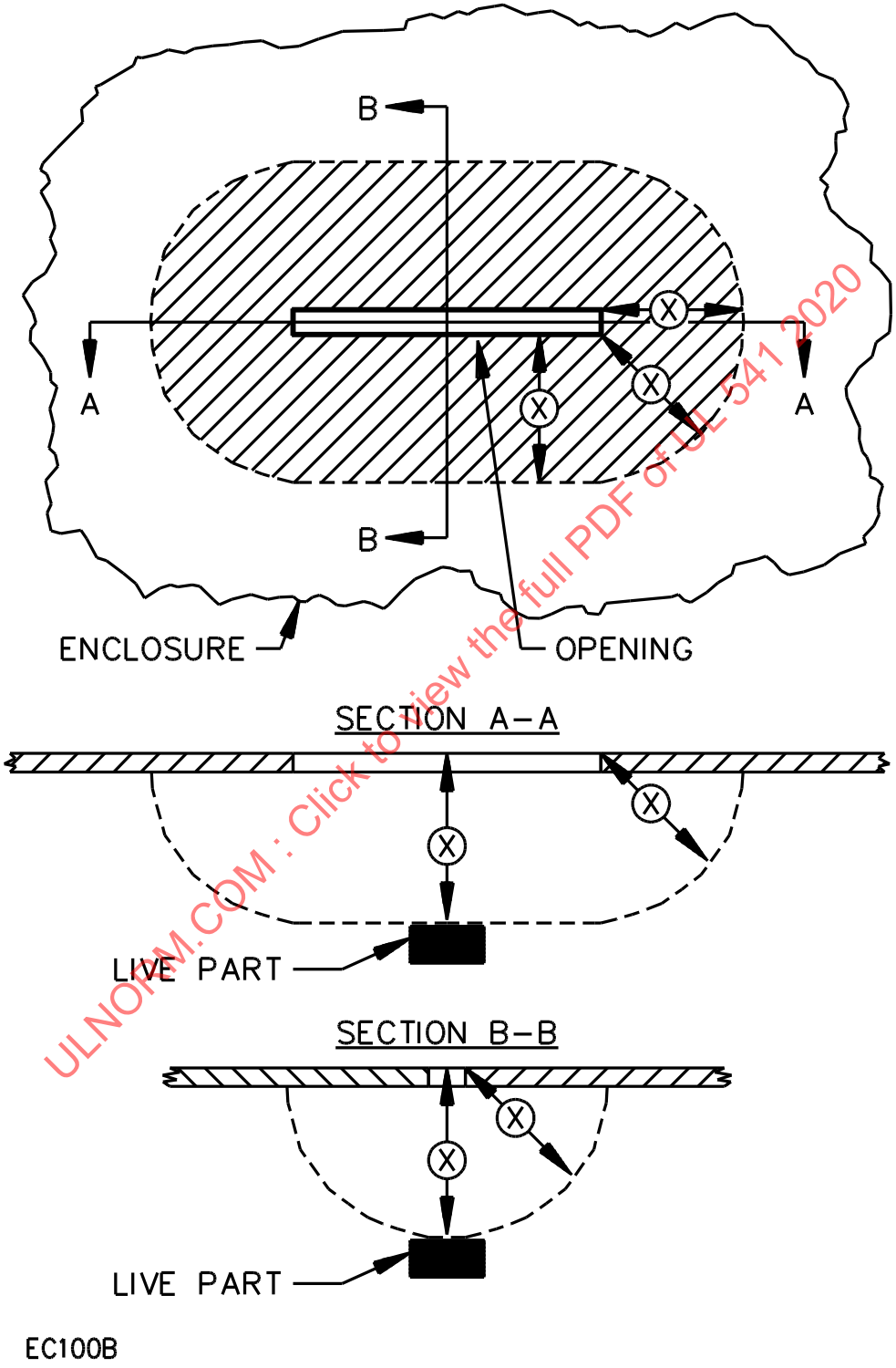


Figure 13.3

Opening in enclosure

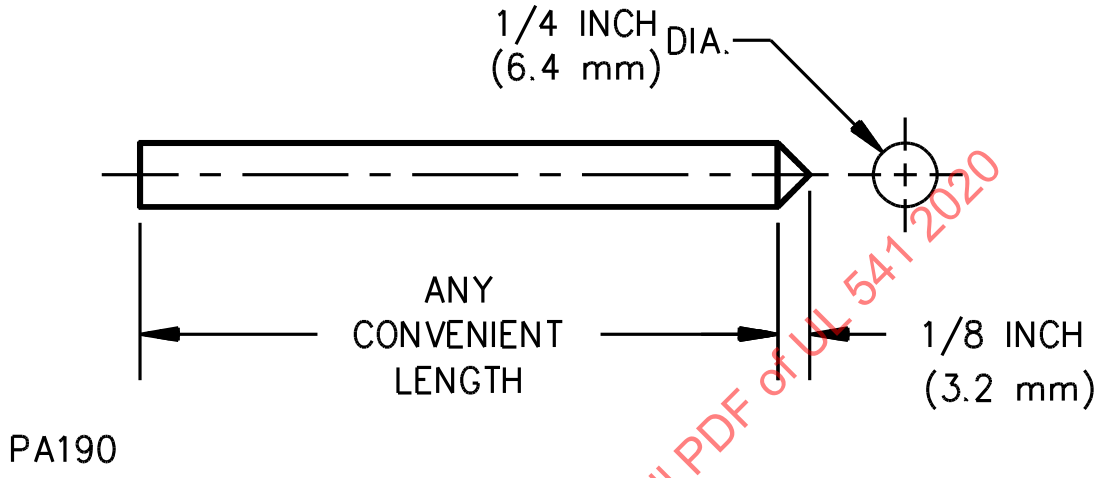


The opening is acceptable if, within the enclosure, there is no uninsulated live metal part or film-coated wire (1) less than X inches (mm) from the perimeter of the opening, as well as (2) within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm).

13.3.15 An opening in the outer enclosure of a vender is acceptable if a probe as illustrated in Figure 13.4 cannot be made to touch any uninsulated live part or film coated wire when inserted through the opening.

Figure 13.4

Probe



13.3.16 Uninsulated live parts in compartments which are intended to be opened for refilling, coin collecting, relamping, lubricating, control adjusting, control resetting, or other such service operations shall be so enclosed, located, or guarded as to prevent unintentional contact while performing such operations.

13.3.17 The requirement in 13.3.16 necessitates the use of enclosures, covers, or barriers over uninsulated live parts which the service person or route person may inadvertently touch in servicing or adjusting the machine. A cover or barrier which must be removed in performing these functions is not considered as providing the protection required.

13.4 Protection from risk of injury

13.4.1 If the operation of a vender involves the risk of injury, protection shall be provided to reduce the likelihood of injury. See 13.4.2 – 13.4.8.

13.4.2 Each coin return and product discharge opening, including those portions of product discharge chutes which may be accessible to the user, are to be evaluated to determine compliance with 13.4.1.

13.4.3 The details of guards, safety releases, pressure relief valves, interlocks, and the like, are not specified; but the need for such accessories and the adequacy of any such accessory provided are to be determined from a study of the complete appliance, its operating characteristics, and the risk of injury resulting from other than gross negligence.

13.4.4 With reference to the requirement in 13.4.3, the degree of protection required of the enclosure depends upon the general construction and intended use of the 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 risk of unintentional contact with the moving parts;

d) The speed of movement of those parts; and

e) The risk of fingers, arms, 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.

13.4.5 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.

13.4.6 A guard shall be provided over a moving part that may cause injury to the service person or route person when a cover, door, panel, or other closure is opened or removed.

13.4.7 If the guard mentioned in 13.4.6 must be removed during servicing of a part, the guard shall be constructed and arranged so it can be easily removed and replaced.

13.4.8 An edge, projection, or corner of an enclosure, frame, guard, handle, or the like, shall be smooth, rounded, and not sufficiently sharp to constitute a risk of injury to persons during the intended use and maintenance of the appliance.

14 Supply Connections for Permanently Connected Venders

14.1 General

14.1.1 Venders of the following types shall have provision for permanent connection to the power supply in accordance with ANSI/NFPA 70:

a) Units rated in excess of 250 volts;

b) Polyphase units; and

c) Units employing a water-cooled condenser.

14.1.2 As used in Terminals, Section 14.2, and Leads, Section 14.3, 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 vender is installed.

14.1.3 The wiring of a permanently connected vender 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 vender.

14.1.4 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 14.1.6 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.

14.1.5 The outlet box or compartment to which power supply connections are made shall be accessible for inspection after the vender is installed. 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.

14.1.6 The vender shall be provided with field-wiring terminals for connection of supply-circuit conductors. The terminals or leads sizes shall not be less than the size required by 103.10. It is assumed that branch circuit conductors rated 140°F (60°C) will be used.

14.2 Terminals

14.2.1 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.

14.2.2 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.

14.2.3 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 14.1.6, and 103.10 but no smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

14.2.4 Wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with 14.2.5 – 14.2.10 or with UL 486E.

14.2.5 If a wire-binding screw is employed at a wiring terminal for the connection of supply circuit conductors, it shall be:

a) Not smaller than 8 (4.2 mm^2 diameter) for 14 AWG (2.1 mm^2) supply circuit conductors; and

b) Not smaller than 10 (4.8 mm^2 diameter) for 12, 10, or 8 AWG (3.3, 5.3, or 8.3 mm^2) supply circuit conductors.

14.2.6 A terminal plate for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) in thickness and shall have not less than two full threads in the metal, except that a plate not less than 0.030 inch (0.76 mm) in thickness is acceptable for 14 AWG (2.1 mm^2) conductors.

14.2.7 A terminal plate formed from stock having the minimum required thickness, as given in 14.2.6, may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

14.2.8 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.

14.2.9 A wire-binding screw shall thread into metal.

14.2.10 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 ground conductor shall be shown in some other manner, such as on an attached wiring diagram.

14.3 Leads

14.3.1 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 51.3 shall comply with all of the following:

a) Be one of the types of wiring specified in 17.1.2;

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 86.1 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 50 for high-voltage circuits or Low-Voltage Circuits, Section 51 for low-voltage circuits.

14.3.2 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.

15 Supply Connections for Cord Connected Venders

15.1 A vender 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.

15.2 With reference to 15.1, a power supply cord and plug shall comply with UL 817.

15.3 A cord-connected vender shall be provided with a factory installed ground-fault circuit-interrupter (GFCI).

15.4 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.

15.5 The GFCI on a vender intended for outdoor use shall be rated for outdoor use.

15.6 The rating of the attachment-plug shall be not less than 125 percent of the marked rating of the vender and not less than the total current measured during the Temperature and Pressure Tests, Section 63. The total current shall include the current drawn by accessories intended for use with the vender.

15.7 Except as specified in 15.8, the grounding-type attachment-plug shall comply with the ANSI designation as specified in Table 15.1 based on the vender voltage and ampere rating.

Table 15.1
Attachment-plug rating

Amperes	Volts	ANSI designation[a]
15	125	5-15
20	125	5-20
30	125	5-30
15	250	6-15
20	250	6-20
30	250	6-30

[a] Designations in accordance with NEMA WD6

15.8 With reference to 15.7, if the grounding-type attachment plug does not comply with the ANSI designation specified in Table 15.1, 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 the first column of Table 60.1.

15.9 A cord connected vender shall use a Type S, SE, SEO, SJ, SJE, SJEO, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, ST, STO, SJO, or STOO power supply cord as specified in ANSI/NFPA 70. The voltage rating of the power supply cord shall not be less than the rated voltage of the vender. The ampacity of the power supply cord shall be the higher of the values specified in 15.10.

15.10 With reference to 15.9:

a) If a vender is intended for connection to a branch circuit that exceeds the ratings specified in 29.3.2, the ampacity of the power supply cord shall not be less than 80 percent of the maximum continuous current of the motor-compressor determined in accordance with Protective Devices – Maximum Continuous Current Test, Section 82, plus the sum of all other loads, including accessories, which may operate concurrently.

b) The ampacity of the power supply cord shall not be less than the current measured in the Temperature and Pressure Tests, Section 63.

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

15.11 The power supply cord for a vender intended for outdoor use shall be one of the types specified in 15.9 and marked on the jacket with the designation of "W" following the cord type designation.

15.12 The length of the power supply cord shall be not more than 10 feet (3.0 m) and not 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 vender cabinet or the last strain relief, whichever is shorter.

15.13 The edges of the entry hole for the power supply cord, including the cord entry hole in a bushing if a bushing is provided, shall be smooth and rounded, without burrs, fins, or sharp edges which might damage the cord insulation.

15.14 The power supply cord shall be provided with strain relief means so that a strain on the cord will not be transmitted to terminals, splices, or internal wiring. The strain relief means shall comply with 86.1 when subjected to a direct pull of 35 pounds-force (156 N).

15.15 If a flexible cord is capable of being pushed into the vender through the cord-entry hole, any such displacement shall not result in the conditions specified in (a) – (d). Compliance shall be determined in accordance with Push-Back Strain-Relief Test, Section 87:

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.

15.16 Except as specified in 15.17, if an accessory is powered from a source of supply separate from that supplying a cord-connected vender, disconnection of any one power-supply cord shall automatically cause de-energization of all circuits within the vender and accessory.

15.17 With reference to 15.16, if a vender does not automatically de-energize all circuits, then the vender shall be provided with the marking specified in 101.9.

15.17.1 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 15.9 and provided with an equipment grounding conductor in accordance with 15.18;

d) Each attachment plug shall be as specified in 15.6 – 15.8;

f) The markings specified in 103.27.1(a) and (c) shall be provided; and

g) The instructions shall contain the information specified in 106.7.

15.17.2 In reference to 15.17.1, 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 103.27.1(b).

15.18 The power supply cord shall be provided with an equipment grounding conductor terminating within the equipment. The 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 equipment 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 Grounding and Bonding for Grounding

16.1 General

16.1.1 Except as specified in 16.1.2, a vender shall have provision for the grounding of all exposed or accessible noncurrent carrying metal parts which may be contacted by the user or by route and service personnel during service operations which are likely to be performed when the vender is energized.

16.1.2 Metal parts that do not comply with 16.1.1 shall be one of the following:

a) Adhesive attached metal foil markings, screws, handles, and the like, which are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.

b) Isolated metal parts, such as magnet frames and armatures or small assembly screws, which are positively separated from wiring and uninsulated live parts.

c) Panels and covers which do not enclose uninsulated live parts if wiring is positively separated from the panel or cover so that it is not likely to become energized.

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar materials at least 0.028 inch (0.71 mm) thick, and secured in place.

16.1.3 Metal-to-metal hinge bearing members may be considered as a means for bonding the door for grounding.

16.1.4 A separate component bonding conductor shall be of copper, a copper alloy, or other material suitable for use as an electrical conductor. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage or be located within the confines of the outer enclosure or frame; and

b) Not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

16.1.5 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, or by welding, soldering, or brazing with materials having a softening or melting point greater than 455° C (850° F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.

Exception: A connection that depends upon the clamping action exerted by rubber or similar material may be acceptable if it complies with 16.1.7 under any normal 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 which may occur in service. Also, the effect of assembling and disassembling, for maintenance purposes, such a clamping device is to be considered with particular emphasis on the likelihood of the clamping device being reassembled in its intended position.

16.1.6 If the adequacy of a bonding connection cannot be determined by examination, it shall be considered acceptable if the connecting means does not open when tested as described in 16.1.7.

16.1.7 With reference to 16.1.6, 16.2.1, and 16.3.1 a bonding connection or a bonding conductor shall be considered acceptable if it does not open:

a) When carrying twice the current equal to the rating of the branch circuit overcurrent device for the interval indicated in Table 16.1; and

b) In a short circuit test in series with a fuse of proper rating. See Limited Short Circuit Test, Section 81.

Table 16.1
Current overload test

Rating of overcurrent protection device amperes	Minimum duration of current flow minutes
30 or less	2
31 – 60	4
61 – 100	6

16.1.8 A bonding conductor to a component or electrical enclosure is not required to be larger than the size of the conductors supplying power to the component or components within the enclosure.

16.1.9 If more than one size branch circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent 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 device smaller than other overcurrent devices used with the equipment, a bonding conductor for that motor is sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

16.1.10 The means for grounding shall be 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 in the cord of a cord-connected vending machine.

16.1.11 With reference to 16.1.10(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 16.3 for permanently connected venders 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 103.34.

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

16.2 Cord connected venders

16.2.1 On a cord connected vender, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord.

Exception: A smaller conductor may be used if the bonding conductor and connection do not open when tested as described in 16.1.7.

16.3 Permanently connected venders

16.3.1 Except as specified in 16.1.7 or 16.1.8, the size of a conductor or strap employed to bond an electrical enclosure or motor frame shall comply with Table 16.2 for a:

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

b) Stand-alone solar PV system vending machine having provision for a permanent connection to a grounding means, based on the rating of the overcurrent protective device required in accordance with 47.5.

Table 16.2
Bonding wire conductor size

Rating of overcurrent device, amperes	Size of Bonding Conductor[a]			
	Copper Wire		Aluminum Wire	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)

[a] Or equivalent cross-sectional area.

16.3.2 On permanently connected venders, a terminal solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size applicable for the application, in accordance with ANSI/NFPA 70.

16.3.3 On a permanently connected vender 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, GROUND, GROUNDING, or the like, or by the symbol

or by a marking on a wiring diagram provided on the vender. The wire-binding screw or pressure wire connector shall be secured to the frame or enclosure of the vender and shall be so located that it is unlikely to be removed during servicing of the vender.

16.3.4 On permanently connected venders, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

17 Internal Wiring and Wiring Methods

17.1 General

17.1.1 Wiring shall have insulation rated for the potential involved and the temperatures to which it may be subjected. Compliance shall be determined in accordance with any of the following:

a) Wiring temperatures shall be evaluated on the basis of the temperatures measured during the applicable temperature tests specified in Temperature and Pressure Tests, Section 63 and Heating Test, Section 65.

b) Other than motor wiring, all wiring shall:

1) Have an ampacity of the conductors in accordance with Table 17.1; 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 or maximum operating current rating in addition to complying with (b).

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

17.1.3 Except as specified in 17.1.4 or 17.1.5, conductor insulation shall be neoprene, thermoplastic or rubber not less than 1/16 inch (1.6 mm) for 16 AWG (1.3 mm^2) and smaller conductors, and 5/64 inch (1.98 mm) for 14, 12 or 10 AWG (2.1, 3.3 or 5.3 mm^2) conductors.

17.1.4 Wiring with neoprene or thermoplastic conductor insulation not complying with 17.1.3 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 complying with UL 224 and having a wall thickness not less than 0.028 inch (0.71 mm); or

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 13.3.14(a)(1) and 13.3.14(b); and

6) Not routed between stationary and movable parts.

17.1.5 Wiring with rubber insulation not complying with 17.1.3 shall be not less than 3/64 inch (1.2 mm) thick. In addition such wiring shall comply with 17.1.4(a), (b), or (c).

17.1.6 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.

17.1.7 Wire positioning devices shall comply with UL 1565.

17.1.8 The insulation of wires or cords connected to fan motors and other auxiliary motors shall be of an oil resistant type, such as Types SJO, SJT, and SJTO, or appliance wiring materials having oil resistant insulation.

Table 17.1
Wiring materials ampacities

Wire size		Ampacity[a]
AWG	mm^2	
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

[a] The ampacities shown apply to appliance wiring materials. For types of wires other than appliance wiring materials, the ampacity is determined from Tables 310-16 and 310-17 as specified in ANSI/NFPA 70 for the type of wire used. The correction factors specified in the reference tables is not required to be applied.

17.1.9 With reference to 17.1.1, high voltage circuit conductors supplying more than one motor or a motor together with other loads shall have an ampacity not less than the higher of one of the following:

a) 125 percent of the full load or maximum operating current rating of the largest motor plus the full load or maximum operating current rating of any other motors or other loads supplied.

b) 125 percent of the rated load or maximum rated current rating of the largest motor-compressor plus the full load or maximum operating current rating of any other motors or other loads supplied.

17.1.10 Enclosed wiring shall be installed so that water resulting from condensation or defrosting will not be retained within the enclosure.

17.1.11 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 vender, such wiring shall comply with 17.1.1 – 17.1.5.

17.1.12 All internal wiring of a vender shall be supported and routed to prevent damage due to contact with:

a) Sharp edges;

b) Moving parts;

c) Parts, such as motors, motor-compressors, and refrigerant lines which may vibrate in operation.

17.1.13 Venders require frequent opening of the door for replenishing the commodity, coin collecting, lubricating, control adjustment, relamping, and other incidental operations. The internal wiring shall be installed and protected so that it is not likely to be damaged during such service operations. Strain relief means shall be provided for wires or cords at an attachment plug or other electrical component which may be removed or disconnected during such service operations.

17.1.14 On venders intended for outdoor use, the wiring assembly shall be so constructed and located as to exclude water from electrical enclosures in accordance with 67.2, and all wires and cords shall be routed and supported so that they will not be immersed in water.

17.1.15 Where wiring extends from the cabinet to a hinged door or to other parts which may be moved, stranded conductors shall be used, and the arrangement shall prevent undue twisting or stressing of conductors as a result of the movement. See 17.1.16.

17.1.16 Wiring which is subjected to movement shall be tested in accordance with the Wiring Endurance Test, Section 88, if movement of the wiring is likely to cause a risk of fire, electric shock or injury to persons.

17.2 Splices

17.2.1 Each splice shall be mechanically secured and electrically bonded. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of fire or electric shock.

17.2.2 Each splice shall be located and supported so that it is not subject to mechanical damage, flexing, motion, or vibration due to air movement, and the like. The insulation on the splice shall be equivalent in thickness, voltage rating, and temperature rating to that required on the conductors.

17.2.3 Splicing devices, such as fixture-type splicing connectors and pressure wire connectors, shall 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. Thermoplastic tape shall not be wrapped over a sharp edge.

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

17.2.5 Wire binding screws shall thread into metal. At terminals, stranded conductors shall be secured by soldered or pressure-type terminal connectors, or the conductors shall be soldered or otherwise assembled to prevent loose strands after assembly. Soldered connections shall be made mechanically secure before being soldered. Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means.

17.2.6 The shanks of terminal connectors shall be protected by electrical insulation if the spacings may be reduced below the minimum acceptable values by slight loosening of the clamping means. The insulating material shall be secured in position. The thickness of the insulation on the shanks shall be not less than 0.028 inch (0.71 mm) except as permitted by 50.7.

17.3 Printed wiring boards

17.3.1 A printed wiring board shall have a flammability rating of V-1 or better when tested in accordance with the vertical flame test described in UL 94.

18 Separation of Circuits

18.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of different circuits (internal wiring) shall be separated by barriers or shall be segregated and shall, in any case, be so separated or segregated from uninsulated live parts connected to different circuits.

18.2 Segregation of insulated conductors may be accomplished by clamping, routing, or other means which provide permanent separation from insulated or uninsulated live parts of a different circuit.

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

18.4 If a barrier is used to provide separation between the wiring of different circuits, it shall comply with 11.1 and be of a rigid insulating material secured in place.

ELECTRICAL COMPONENTS

19 Current-Carrying Parts

19.1 Except for multimetallic thermal elements and heater elements of a thermal protector, all current-carrying parts of a vender shall be of silver, copper, a copper alloy, or other material acceptable for use as an electrical conductor.

19.2 A current-carrying part shall be of silver, copper, copper alloy, stainless steel or other material inherently resistant to corrosion and acceptable for use as an electrical conductor.

19.3 In reference to 19.2, ordinary iron or steel shall not be used for a current-carrying part unless it is provided with a corrosion-resistant coating or located within a motor.

19.4 Uninsulated live parts in high voltage circuits shall be so secured to the mounting surface that they will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum acceptable values. Friction between surfaces is not acceptable as a means to prevent shifting or turning of live parts, but a toothed lock washer, properly applied, may be accepted.

20 Insulating Material

20.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other material with consideration given to its electrical and mechanical properties.

20.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Plastic materials may be used for the sole support of uninsulated live parts if found to have mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric voltage withstand, and other factors involved with the application without displaying a loss of these properties beyond the minimum acceptable level as the result of aging.

20.3 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, phenolic, cold-molded composition, or fiber.

21 Capacitors

21.1 Capacitors shall comply with UL 810 or shall comply with 21.2 – 21.6.

21.2 A motor-starting or running capacitor shall be housed within a cabinet, enclosure or other similar container which will protect the plates against mechanical damage and which will prevent the emission of flame or molten material resulting from failure of the capacitor. The container shall be:

a) Made of coated or uncoated sheet steel having a thickness of not less than 0.020 inch (0.51 mm); or

b) Mounted within the vender cabinet or enclosure if the sheet steel is thinner than 0.020 inch (0.51 mm) or if materials other than metal are used as the capacitor container.

c) Protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard, including faulted overcurrent conditions as specified in the Limited Short-Circuit Test, Section 81. The conditions for the Limited Short-Circuit Test shall be:

1) Based on the circuit on which the capacitor is used; or,

2) If the available fault current is limited by other components in the circuit, such as a motor start winding, the capacitor may be tested using a fault current less than the test current specified in Table 81.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

21.3 *Deleted*

21.4 The individual enclosure of an electrolytic capacitor with means for venting shall be such as to provide protection against physical damage only. The minimum enclosure thickness is not specified.

21.5 The individual enclosure of an electrolytic capacitor not provided with means for venting and with an opening (gap) of more than 1/16 inch (1.6 mm) width need not comply with the requirement for enclosure thickness given in 21.2 if it complies with the following: Three samples of the capacitor, mounted in the usual manner and with cotton placed around openings in the enclosure, are to be subjected to such overvoltage as to cause failure. If the cotton ignites upon failure of the capacitor, the results are not acceptable.

21.6 If the container of an electrolytic capacitor is metal, the container shall be considered as a live part and shall be provided with moisture resistant insulation to isolate it from dead metal parts and to reduce the risk of contact during servicing operations. The insulating material shall be not less than 1/32 inch (0.8 mm) thick, except as indicated in 50.7.

21.7 *Deleted*

21.8 Across-the-line capacitors, antenna-coupling components, line-bypass components and fixed capacitors for use in electronic equipment shall comply with the UL 60384-14.

21.9 In reference to 21.8, a capacitor complying with UL 60384-14 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 and Pressure Test, Section 63 or the Heating Test, Section 65, whichever is higher, 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; and

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

21.10 In reference to 21.8, 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).

22 Control Circuit Conductor Overcurrent Protection

22.1 Glossary

22.1.1 For the purpose of these requirements the following definitions apply.

22.1.2 Control circuit – A circuit that carries electrical signals directing the performance of a controller which, in turn, governs power delivered to a motor or other load in the vender. A control circuit does not carry main power current. If a control circuit is supplied through a transformer provided as part of the vender, see Transformer Protection, Section 31, for additional requirements.

22.1.3 Direct-connected high-voltage control circuit – A circuit that is supplied from a branch circuit separate from a branch circuit that supplies other loads within the vender. It is not tapped from the load side of the overcurrent device or devices of any controlled circuit within the vender. See 103.22.

22.1.4 Tapped high-voltage control circuit – A circuit that is tapped within the vender from the load side of the overcurrent device or devices for the controlled load.

22.2 Tapped high-voltage control circuits

22.2.1 A tapped high-voltage control circuit conductor shall be provided with overcurrent protection. The rating of the overcurrent protective device or devices shall not exceed the applicable value specified in Table 22.1.

Exception No. 1: 18, 16, and 14 AWG (0.82, 1.3, and 2.1 mm^2) conductors that do not exceed 4 feet (1.2 m) in length between points of opposite polarity may be protected by fuses or circuit breakers rated 60 amperes or less.

Exception No. 2: An overcurrent protective device of a higher rating may be used if the conductors withstand short-circuiting when tested as specified in the Limited Short-Circuit Test, Section 81.

Exception No. 3: A lead 12 inches (305 mm) or less in length need not be provided with overcurrent protection.

Exception No. 4: A control-circuit conductor, supplied from the secondary of a single-phase transformer that is connected so that only a 2-wire (single voltage) secondary is used, may be protected by an overcurrent device(s) located on the primary side of the transformer provided:

a) This protection is in accordance with the requirements specified in Transformer Protection, Section 31; and

b) The rating of the device does not exceed the applicable value specified in Table 22.1 multiplied by the ratio of secondary-to-primary rated transformer voltage.

Table 22.1
Overcurrent protective device rating for control circuit conductors

Tapped control-circuit conductor size,		Maximum rating of overcurrent protective device, amperes			
		Conductors contained in control equipment enclosure		Conductors extending beyond control equipment enclosure	
AWG	(mm^2)	Copper	Aluminum[a]	Copper	Aluminum[a]
18	0.82	25	–	7	–
16	1.3	40	–	10	–
14	2.1	100	–	45	–
12	3.3	120	100	60	45
10	5.3	160	140	90	75
Larger than 10		b	b	c	c

[a] Includes copper-clad aluminum.

[b] 400 percent of value specified for 60°C conductors in Table 310-17 as specified in ANSI/NFPA 70.

[c] 300 percent of value specified for 60°C conductors as specified in Table 310-16 of ANSI/NFPA 70.

22.2.2 A control circuit conductor that is tapped from the main power circuit at a point outside of the control equipment enclosure shall be protected as specified in Column A of Table 430-72(b) of ANSI/NFPA 70.

22.2.3 Overcurrent protection for a tapped high-voltage control circuit conductor, as required by 22.2.1, shall be provided as part of the vender.

Exception: The overcurrent protection device(s) need not be provided as part of the vender if, based on the marked rating(s) of the vender, the rating of the branch circuit overcurrent protective device(s) does not exceed the values specified in Table 22.1.

22.2.4 A control circuit overcurrent protective device(s) shall:

a) Be provided for all ungrounded conductors;

b) Be sized in accordance with requirements in 22.2.1;

c) Have a voltage rating not less than the circuit in which it is used; and

d) A circuit breaker acceptable for branch circuit protection or a fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 103.21.

Exception: If the control circuit is tapped from a circuit supplying other loads in the vender, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 81.1. If the supplementary type device used is a fuse, the vender shall be marked in accordance with the Exception to 103.21.

23 Short-Circuit Protection

23.1 Overcurrent protective devices and thermal protective devices for motors shall comply with the requirements of the Limited Short-Circuit Test, Section 81.

24 Dispenser Mechanism

24.1 The components of a mechanism intended to dispense cups and control ingredient delivery shall not exceed their maximum allowable temperatures and shall be rated for the loads which they control as determined during the Temperature and Pressure Tests, Section 63.

25 Coin or Credit Mechanism

25.1 The components of a coin or credit mechanism shall not exceed their maximum allowable temperatures and shall be rated for the loads which they control as determined during the Temperature and Pressure Tests, Section 63. Except as indicated in 25.2, the mechanism shall be installed in the vender at the factory.

25.2 If a coin or credit mechanism is intended for installation in the field, the mechanism and vender shall comply with the requirements of 25.3 – 25.6 and 104.1 and 104.3.

25.3 The installation of a coin or credit mechanism shall be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors. Unless bonding for grounding is accomplished automatically by the intended mounting of the mechanism in the vender, a separate bonding conductor shall be provided in the receptacle and plug-in connector.

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

25.5 As part of the investigation, coin or credit mechanisms are to be trial-installed to determine that their installation is feasible, that the instructions are detailed and correct, and that the installation and use of the mechanism does not cause a risk of electric shock, fire, or injury.

25.6 Venders provided without coin or credit mechanisms are to be evaluated for accessibility of live or hazardous moving parts on the basis that the mechanism is not installed and the vender enclosure is open to the extent permitted by the absence of the coin or credit mechanisms.

26 Lighting Systems

26.1 General

26.1.1 Lampholders and indicating lamps shall comply with UL 496.

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

26.1.3 If a vender is intended to be connected to the 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 that conductor.

26.2 Electric-discharge lighting systems

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

26.2.2 Fluorescent lamp starters shall comply with UL 542.

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

26.2.4 A vender 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.

26.2.5 A vender 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; except that nonshort-circuiting type lampholders may be used if the vender 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.

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

26.2.7 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.

26.2.8 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.

26.2.9 Except where electric lampholders having recessed inaccessible contacts intended for use with lamps having recessed inaccessible contacts are employed, compliance with 26.2.7 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 is open during the relamping operation and all live parts are inaccessible when the lamps are removed and the primary circuit is reestablished.

26.2.10 Lampholders and ballasts installed in moist areas, such as within the refrigerated compartment, shall be constructed of moisture resistant materials or treated to resist absorption of moisture.

26.2.11 Other than as specified in 26.2.12, ballasts shall be provided with a housing of nonflammable, moisture-resistant material.

26.2.12 With reference to 26.2.11, 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 comply with 26.2.13.

26.2.13 A vent opening in an open-core-and-coil reactor type 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^2). 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 5 inches (127 mm) from surfaces of flammable material, except that openings in a ballast compartment surface perpendicular to or facing away from a flammable surface shall be at least 1/2 inch (12.7 mm) from such material.

26.2.14 The Heating Test, Section 65 shall be conducted on an electric-discharge lighting system if:

a) The ambient temperature in which a ballast operates exceeds 104°F (40°C) during the test in Temperature and Pressure Tests, Section 63;

b) The ballast is subject to any sources of external heat, such as an electric heating element; or

c) A lamp starter is provided.

27 Fuseholders

27.1 A fuseholder shall be installed or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing a fuse. 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.

27.2 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.

27.3 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.

27.4 Plug fuseholders of the Edison-base type shall be provided with an adapter designed for Type S fuses.

28 Motors

28.1 Nonhermetic motors shall comply with UL 1004-1. Hermetic motor-compressors shall comply with UL 60335-1 and UL 60335-2-34.

28.2 Each motor having openings in the enclosure or frame shall be arranged to prevent particles from falling out of the motor onto flammable material within or under the vender.

28.3 The requirement in 28.2 will necessitate the use of a barrier of nonflammable material under an open-type motor unless:

a) The structural parts of the motor or vender, such as the bottom closure, provide the equivalent of such a barrier; or

b) The motor protective overload device provided with an open-type motor is such that no burning insulation or molten material falls to the surface that supports the vender when the motor is energized under each of the following fault conditions applicable to the motor type:

1) Open main winding;

2) Open starting winding;

3) Starting switch short-circuited;

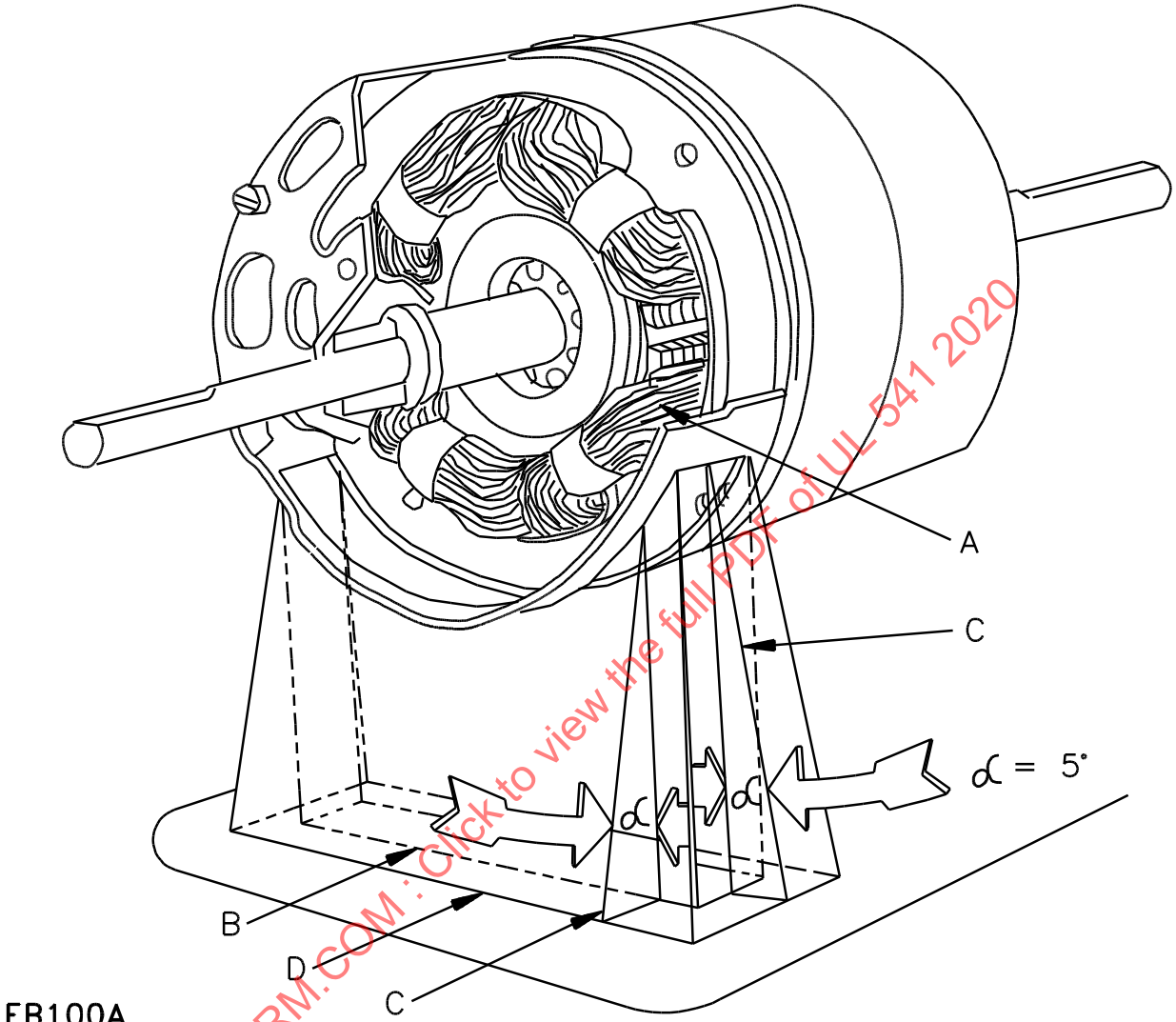
4) Capacitor shorted (permanent split capacitor type); or

c) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) that will limit the temperature of the motor windings to 125°C (257°F) or less under the maximum load at which the motor will run without causing the protector to cycle, and from becoming more than 150°C (302°F) with the rotor of the motor locked.

28.4 The barrier referred to in 28.3 shall be horizontal, shall be located as indicated in Figure 28.1, and shall have an area not less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier, provided that such openings would not permit molten material, burning insulation, or the like, to fall on flammable material.

Figure 28.1

Location and extent of barrier



A – Motor winding to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding which is partially shielded by the motor enclosure or equivalent.

B – Projection of outline of motor winding on horizontal plane.

C – Inclined line which traces out minimum area of the barrier. When moving, the line is to be always (1) tangent to the motor winding, (2) five degrees from the vertical, and (3) so oriented that the area traced out on a horizontal plane is maximum.

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

28.5 If an automatic-reset type of protective device is employed, the automatic restarting of the motor shall not result in a risk of accident.

28.6 The requirement in 28.5 may necessitate the use of an interlock in the vender if moving parts or the like may cause injury to persons upon the automatic restarting of the motor.

29 Motor Overload Protection

29.1 General

29.1.1 A fuse shall not be used as a protective device unless the motor is protected by the largest size fuse that can be inserted into the fuseholder.

29.1.2 Overcurrent protective devices and thermal protective devices for motors shall comply with applicable short-circuit requirements for the class of protective device and shall, in addition, comply with the requirements of the Limited Short-Circuit Test, Section 81.

29.2 Protection of single-phase nonhermetic motors

29.2.1 All single-phase motors other than a hermetic refrigerant motor compressor shall be protected by one of the following:

a) By a separate device responsive to motor current and rated or set to trip at not more than the percentage of the motor nameplate full-load or maximum operating current rating as specified in Table 29.1;

b) By a separate overload device which combines the functions of overload and overcurrent protection and is responsive to motor current rated or set at values not greater than the percentages of the motor nameplate full-load or maximum operating current rating as specified Table 29.1. Such a device shall be capable of fully protecting the circuit and motor both under overload and short circuit conditions;

c) In accordance with UL 1004-2 for impedance protected motors;

d) In accordance with UL 1004-3 for thermally protected motors; or

e) In accordance with 29.5 or UL 1004-7 for electronically protected motors.

Table 29.1
Overload relay size

	Maximum percentage protection	
	A	B
Motor with a marked service factor no less than 1.15	125	140
Motor with a marked temperature rise not more than 40°C (72°F)	125	140
Any other motor	115	130

29.2.2 In reference to 29.2.1(a) and (b), if the percentage protection specified in Column A of Table 29.1 does not correspond to the percentage value of an overload device of a standard size, the device of the next higher size may be used. However, the overload device of the next higher size shall provide protection no higher than that indicated in Column B of Table 29.1.

29.3 Protection of single-phase hermetic refrigerant motor-compressors

29.3.1 Single-phase hermetic refrigerant motor-compressors shall be protected by one of the following:

a) A separate overload relay that is responsive to motor compressor current and will trip at not more than 140 percent of the rated load or maximum rated current of the motor compressor;

b) A thermal protector integral with the motor compressor or a protective system that complies with the applicable requirements in UL 60335-1 and UL 60335-2-34; or

c) an overcurrent device, such as a fuse or circuit breaker, responsive to motor current, and rated at no more than 125 percent of the motor-compressor rated-load or maximum rated current of the motor-compressor.

29.3.2 In reference to 29.3.1(b), a motor-compressor protector or protective system shall not permit a continuous current in excess of 156 percent of the motor-compressor rated load current or branch-circuit selection current (if the latter is marked) unless.

a) The vending machine is intended for connection to a 15- or 20-ampere, 120-volt or a 15-ampere, 208- or 240-volt, single-phase branch circuit; or

b) The motor-compressor protector or protective system is provided by an adjustable speed drive or system.

29.3.3 Each component of the "protective system" mentioned in 29.3.1(b) shall be provided as part of the vender.

29.3.4 The values of rated-load current and branch-circuit-selection current specified in 29.3.2 shall be the values marked on the vender nameplate. For a cord-connected vender or a permanently connected vender marked with a single-ampere rating, the rated load current as specified in 29.3.2 shall be the current drawn by the motor-compressor during the Temperature and Pressure Test, Section 63.

29.4 Protection of three-phase motors

29.4.1 Three-phase motors shall be protected by:

a) Three properly rated overcurrent units, each complying with 29.2 or 29.3; or

b) Other protective methods if the methods provide protection under primary single-phase failure conditions when supplied from wye-delta or delta-wye connected transformers. Water coolers with such protective methods shall be marked as described in 103.20.

29.5 Protective electronic circuits

29.5.1 A protective electronic circuit providing motor protection in accordance with 29.2, 29.3 or 29.4 shall comply with one of the following:

a) *Deleted*

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

c) Paragraph 30.1.30 and the Protective Electronic Circuits Tests, Section 95; 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.

29.5.2 With reference to 29.5.1, 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: 0.0 ±2°C (32.0 ±3.6°F) and 40.0 ±2°C (104 ±3.6°F);

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

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 95.3.4 and 95.3.2;

g) Exposure to humidity with the following conditions:

1) Indoor use: 21.1 – 26.7°C (70 – 80°F) 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 95.3.8 and 95.3.2;

m) Harmonics and Interharmonics – Evaluate in accordance with 95.3.9 and 95.3.2; and

n) Calibration (deviation and drift): Evaluate in accordance with 30.1.21 for a temperature protective control or 30.1.22 for a pressure protective control.

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

a) *Deleted*

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

c) Software Evaluation, Annex R in 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.

30 Switches and Controllers

30.1 General

30.1.1 A motor controller shall be provided for each motor:

a) For permanently connected venders– the branch circuit overcurrent device may serve as the controllers for motors rated 1/8 horsepower (93 W output) or less which are intended to be left running and are so constructed that they cannot be damaged by overload or failure to start, such as a clock motor, and the like;

b) For cord connected venders – the attachment plug and receptacle may serve as the controller for motors rated at 1/3 horsepower (249 W output) or less.

30.1.2 Other than as specified in 30.1.4 – 30.1.11, a switch or other control device shall be rated for the load which it controls, as determined in the Temperature and Pressure Tests, Section 63. Items to consider in determining the device rating 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 75.9.

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

30.1.4 In reference to 30.1.2, a switch not rated for the load controlled and that does not comply with 30.1.4 – 30.1.11 shall comply with the requirements of the Overload and Endurance Test – Switching Devices, Section 75.

30.1.5 If a branch circuit selection current value is marked on a vender, a switch or other control device (controller) for a hermetic refrigerant motor-compressor shall have a full-load current rating not less than this marked value plus any additional loads controlled.

30.1.6 A manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of:

a) Rated load current, maximum rated current or branch-circuit selection current of the motor-compressor, whichever is greater; and

b) The rated current for other controlled loads.

30.1.7 The values of current specified in 30.1.6 shall be the values marked on the vender nameplate as required by 103.1.

30.1.8 The current interrupting capacity of a switching device that controls a motor load, such as a motor-compressor, shall equal the locked-rotor current, maximum operating current or maximum rated current of the largest motor load plus the full load or maximum operating current of any other loads controlled by the switch.

30.1.9 A switch that controls an inductive load, such as a transformer or an electric-discharge-lamp ballast, shall have a current rating of not less than twice the total marked current ratings of the transformer, ballast, or other equipment which it controls.

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

30.1.11 For use with tungsten-filament lamp loads:

a) A switch shall have a T or L rating equal to the tungsten-filament lamp load;

b) A general-use alternating-current snap switch, a circuit breaker, or a nonautomatic circuit interrupter are acceptable for controlling tungsten-filament lamps at their full ampacity; and

c) A switch having an alternating-current ampacity of six times or more of the tungsten-filament lamp load is acceptable without additional test.

30.1.12 If circuit breaker or switch handles are operated vertically, the "UP" position shall be the "ON" position.

30.1.13 Each circuit breaker used as a switch in 120 volt fluorescent lighting circuits shall be rated as indicated in 30.1.9 and shall be marked "SWD."

30.1.14 A protective control, other than a motor or motor-compressor overload protective device as specified in Motor-Operated Protection, Section 29, shall comply with one of the following:

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 30.1.29 and the Protective Electronic Circuits Tests, Section 95.

30.1.15 In reference to 30.1.14 (e) – (h), the endurance cycle requirements in UL 60730-2-9, Table CC.2 for cut-outs shall be applied to such controls.

30.1.16 With reference to 30.1.14 (b), (c), (g) and (h), when determining the acceptability of a protective control, the control pollution degree shall be as specified in 52.3 (a) – (d). If the protective control:

a) Has a protective electronic circuit, the items in 29.5.2 (a) – (k) shall be considered; and

b) Uses software as a required part of the protective electronic circuit, the software shall comply with 29.5.3(b) or (c).

30.1.17 Except as specified in 30.1.23, an operating control, including of the electronic type, shall comply with:

a) One of the standards specified in 30.1.14;

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

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

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

30.1.19 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.

30.1.20 A protective control shall:

a) Be an integral part of the product; and

b) Control the load(s) directly except as specified in 30.1.22.

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

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

30.1.23 If a protective control indirectly controls the load through a switching device, the switching device shall comply with the endurance cycle requirements in 30.1.14 or 30.1.15. The switching device shall be an integral part of the product.

30.1.24 An operating control not complying with 30.1.17:

a) Shall be powered entirely by no more than one low-voltage circuit; comply with the Limiting Impedance Test in UL 508; or comply with the low-power test requirement determined as specified in Clause 19.11.1 of UL 60335-1; and

b) If used to control a motor-compressor, shall comply with the endurance cycle requirements in UL 60730-2-9, Table CC.2, for air conditioning and refrigeration applications.

30.1.25 An operating control that complies with 30.1.17 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 95.3.6 and comply with the results specified in 95.3.2;

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 52.3 (a) – (d); and

e) The endurance cycle requirements specified by either:

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 75.

30.1.26 Appendix A, specifying the operating and protective ("safety critical") control functions, shall be referenced to determine whether a control function is considered to result in a risk fire, electrical shock, or injury to persons.

30.1.27 If an operating control complying with 30.1.17 indirectly controls a load through a switching device, the switching device endurance cycle requirements shall be as specified in:

a) 30.1.24(b) if the switching device controls a motor-compressor; or

b) 30.1.25(e) if the switching device controls a load other than a motor-compressor.

30.1.27.1 If an operating control referenced by 30.1.24 indirectly controls a motor-compressor through a switching device, the switching device endurance cycle requirements shall comply with 30.1.24(b).

30.1.28 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 30.1.14. 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 30.1.23 or with 30.1.17 and 30.1.24.

30.1.29 A thermistor shall comply with the Requirements for Controls Using Thermistors, Annex J in UL 60730-1 or UL 1434. The calibration shall be as specified in 30.1.20, 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.

30.1.30 A protective control as referenced in 29.5.1(c) or 30.1.14(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 95.2;

c) In which an overcurrent protective device opens during application of any of the fault conditions specified in Fault Conditions Abnormal Tests, Section 95.2, 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 95.2;

d) In which a conductor of the printed wiring board becomes open-circuited during the fault conditions test in Fault Conditions Abnormal Tests, Section 95.2, then:

1) The printed wiring board shall comply with the Needle-Flame Test, 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 50 – 52; 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 50 – 52;

e) Shall maintain its required functions when subjected to the EMC related stresses specified in the Electromagnetic Compatibility (EMC) Tests, Section 95.3; 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 95.4, 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.

30.2 Relays

30.2.1 In addition to the requirements of 30.1.2 – 30.1.8, the following also apply to relays used in venders.

30.2.2 Each coil winding shall be impregnated, dipped, varnished, or equivalently treated to resist absorption of moisture.

30.2.3 Relays shall perform as intended within the voltage range indicated in the Overvoltage and Undervoltage Tests, Section 80.

30.3 Remotely operated venders

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

30.3.2 Except as specified in 30.3.3, a manual control shall be provided on a vender such that actuation of the control is required before the vender can be operated in any mode that permits remote operation, external communication or receiving/sending data signals.

30.3.3 In reference to 30.3.2, a vender 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.

30.3.4 A vender shall include a means to manually disconnect, disable or override any remote operation commands, external communication or data signals. If the vender attachment plug and receptacle serve as the manual means to disconnect data signals or remote operation commands, the vender shall comply with 30.1.1(b) and 106.6.

30.3.5 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 result in 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 vender;

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 vender that could result in exposure of electrical parts, moving parts, hot parts or radiation that could result in a risk of fire, electric shock or injury to persons.

30.3.6 Compliance with 30.3.5 shall be determined by one of the following methods:

a) Using methods appropriate for determining the performance and reliability of protective control functions in accordance with Switches and Controllers – General, Section 30.1; or

b) Examining the vender 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 vender protective controls, and therefore is incapable of adversely affecting the operation of any protective controls.

31 Transformer Protection

31.1 High-voltage transformers

31.1.1 A transformer (including an autotransformer), other than one as described in 31.1.8, is considered to be a high-voltage transformer and shall comply with UL 5085-1 and UL 5085-2. Except as specified in 31.1.2, the transformer shall also:

a) Be provided with thermal overload protection in accordance with the requirements in 31.1.3;

b) Be protected by an overcurrent device in accordance with the requirements in 31.1.5; or

c) Comply with the Burnout Test – High-Voltage Transformers, Section 77.

31.1.2 A transformer not complying with 31.1.1(a), (b) or (c) 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.

31.1.3 If a high-voltage transformer is provided with a thermal overload protective device, the device shall be arranged to interrupt primary current and shall limit temperatures of the transformer windings, under overload conditions, to that for the class of insulation employed in the windings. See Overload Test – High-Voltage Transformers, Section 79. If the thermal overload protective device provided is a nonrenewable thermal cutoff, a burnout test is to be conducted in place of the overload test. See Burnout Test – High-Voltage Transformers, Section 77.

31.1.4 A thermal cutoff shall comply with the requirements of UL 60691.

31.1.4.1 In reference to 31.1.3, a manual or automatic-reset thermal protector shall comply with 30.1.17 and 30.1.25. The calibration of the thermal protector shall comply with 30.1.21.

31.1.5 An overcurrent device used to protect a high-voltage transformer shall comply with the requirements specified in 31.1.6, 31.1.7, 31.2.1 and 31.2.2.

31.1.6 Other than as noted in 31.1.7, each high-voltage transformer shall be protected by an overcurrent device or devices located in the primary circuit. The overcurrent protection shall be rated or set as specified in Table 31.1. See 31.2.1.

Exception: If the rated primary current of the transformer is 9 A or greater and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device is acceptable. Standard ratings of protective devices are specified in ANSI/NFPA 70.

Table 31.1
Rating of overcurrent devices

Rated primary current, amperes		Maximum rating of overcurrent device, percent of transformer primary current rating
Transformer other than an autotransformer	Autotransformer	
Less than 2	–	300[a]
2 or more, less than 9	Less than 9	167
9 or more	9 or more	125

[a] May be increased to 500 percent if transformer supplies a motor control circuit.

31.1.7 If the circuit supplying a transformer, other than an autotransformer, is provided with overcurrent protection rated or set at 250 percent or less of the rated primary current of the transformer, additional overcurrent protection is not required in the primary circuit if:

a) The secondary circuit is protected at 125 percent or less of the rated secondary current of the transformer; and

b) The overcurrent protection in the secondary circuit is provided as part of the vender.

Exception No. 1: If the rated secondary current of the transformer is 9 A or greater and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device shall be used in the secondary circuit. Standard ratings of protective devices are specified in ANSI/NFPA 70.

Exception No. 2: If the rated secondary current of the transformer is less than 9 A, the overcurrent device or devices in the secondary circuit complies when the overcurrent device or devices are rated or set at 167 percent or less of the rated secondary current.

31.1.8 A transformer that directly supplies a ANSI/NFPA 70, Class 2 circuit (see 50.2) shall limit the output current (inherently limited transformer), or be equipped with an overcurrent device (not inherently limited transformer), in accordance with UL 5085-1 and UL 5085-3.

31.2 Overcurrent protective devices

31.2.1 Overcurrent protection in the primary circuit of a transformer, as described in 31.1.6, need not be provided as part of the vender if, based on the marked rating or ratings of the vender, the rating of the branch circuit overcurrent protective device or devices does not exceed the values specified in 31.1.6.

31.2.2 A required transformer overcurrent protective device(s) provided as part of the vender shall:

a) Be provided for all ungrounded conductors;

b) Be sized in accordance with requirements in 31.1.6 and 31.1.7, as applicable;

c) Have a voltage rating not less than the circuit in which it is used; and

d) Be a circuit breaker acceptable for branch circuit protection, or a fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 103.21.

Exception: If a transformer supply is tapped from a circuit supplying other loads in the vender, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 81.1. If the supplementary type device used is a fuse, the vender shall be marked in accordance with the requirements in the exception to 103.21.

32 Valves and Solenoids

32.1 An electrically operated valve or solenoid shall comply with UL 429.

32.2 If a valve must be cleaned periodically, the arrangement shall permit this operation to be performed without damage to the electrical parts of the valve or wiring.

33 Batteries and Battery Chargers

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

33.2 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.

33.3 A battery charger shall comply with 43.1.

34 Circuit Breakers, Fusing Resistors and Supplementary Protectors

34.1 Circuit breakers shall comply with UL 489. In addition, circuit breakers used in telecommunications circuitry shall comply with UL 489A.

34.2 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.

34.3 Fusing resistors shall comply with UL 1412.

34.4 Supplementary protectors shall comply with UL 1077.

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

35 Connectors

35.1 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.

36 Electrical Cable, Conduit and Tubing

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

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

36.3 Electrical steel tubing shall comply with UL 797.

37 Electrical Insulation Systems

37.1 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 unspecified.

37.2 Insulating tape shall comply with UL 510.

37.3 Insulating sleeving shall comply with UL 1441.

37.4 Insulating tubing shall comply with UL 224.

38 Electromagnetic Interference Filters

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

39 Fuses

39.1 Unless otherwise specified, fuses 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.

39.2 If a supplementary fuse is permitted in accordance with the requirements in this standard, such a fuse shall comply with UL 248-1, in conjunction with UL 248-14.

40 Heaters

40.1 Electric resistance heating elements shall comply with the construction requirements in UL 499 or UL 1030.

40.2 The requirements in Heating Test, Section 65 shall be conducted on a vender provided with an electric resistance heating element.

41 Optical Isolators and Semiconductor Devices

41.1 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.

41.1.1 In addition to complying with 41.1, 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 1500V.

41.2 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.

42 Outlet Boxes

42.1 Outlet boxes shall comply with UL 514A or UL 514C. Fittings shall comply with UL 514B. Cover plates shall comply with UL 514D.

43 Power Supplies

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

a) For a Class 2 Power Supply, UL 1310 or UL 60950-1;

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 81A, shall be applied.

43.2 *Deleted*

44 Receptacles

44.1 Receptacles shall comply with UL 498.

44.2 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.

44.3 Receptacles shall be of the grounding type.

44.4 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.

44.5 Overcurrent protection shall be provided as part of the vender for each receptacle. The overcurrent protection shall be provided by a circuit breaker(s) or fuse(s) acceptable for branch circuit use.

45 Terminal Blocks

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

45.2 With reference to 45.1, if a fabricated part performs the function of a terminal block, the part shall comply with Terminals, Section 14.2, Current-Carrying Parts, Section 19, Insulating Material, Section 20, and the spacings requirements as applicable to the type of circuit as specified below:

a) High-Voltage Circuits, Section 50; or

b) Low-Voltage Circuit, Section 51.

45.3 If a fabricated terminal block complies with the alternate spacings requirements in Alternate Spacings – Clearances and Creepage Distances, Section 52, but not with the spacings requirements in High-Voltage Circuits, Section 50, the terminal block shall not be used for field wiring.

46 Wireways, Auxiliary Gutters and Associated Fittings

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

47 Solar Photovoltaic Systems

47.1 Solar photovoltaic (PV) modules or PV cells on a vender or on a frame or other support they have in common shall comply with UL 1703.

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

47.3 A vender with PV modules or cells shall be provided with a factory installed ground-fault circuit-interrupter (GFCI) complying with UL 943. If the vender is:

a) Cord-connected, the GFCI shall comply with 15.3 – 15.5; or

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.

47.4 With reference to 47.3, manual operation of the main PV disconnect shall not activate the GFCI or result in grounded conductors becoming ungrounded.

47.5 A vender 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 the ampacity of the solar PV system source conductors, the marked rating of the charge controllers, converters, inverters or 125 percent of the inverter output current. The overcurrent protective device shall be of the type that is suitable for branch circuit protection.

47.6 A means shall be provided to disconnect all current-carrying conductors of a solar PV system and any additional power source, such as batteries, from all other conductors within the vender. The disconnecting means shall be readily accessible and provided with the marking in 103.28.

47.7 A vender 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 47.5;

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 charger controller fails or is disabled.

47.8 Charging circuits used with PV supplies shall comply with 43.1.

47.9 A vender that includes battery or electrical energy storage devices shall not have more than twenty-four 2 volt cells connected in series (48 volts nominal).

47.10 Overcurrent protection rated 50 volts (48 volts nominal) shall be installed in each battery circuit. The protection shall be accessible and be located adjacent to or near the batteries.

48 Information Technology Equipment

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

49 Across-The-Line Capacitors, Antenna-Coupling Components, Line-Bypass Components and Fixed Capacitors for Use in Electronic Equipment

49.1 *Deleted*

49.2 *Deleted*

SPACINGS

50 High-Voltage Circuits

50.1 The following electrical spacing requirements apply to high-voltage circuits as defined in 5.20.

50.2 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 50.1.

Table 50.1
Electrical Spacings in refrigerated and/or air-handling compartments

Ratings		Minimum spacing in inches (mm)					
Volt-amperes	Volts	Through air[d]		Over surface[d]		To enclosure[c]	
0 – 2000	0 – 300[a]	1/8[b]	(3.2)	1/4	(6.4)	1/4	(6.4)
More than 2000	0 – 150	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] If over 300 volts, spacings in last line of table apply.

[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, the spacing need not be greater than that given in this table. Wiring terminals are those connected in the field and not factory-wired.

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

[d] 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 an 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.

50.3 The "Through Air" and "Over Surface" spacings given in Table 50.1 and Table 50.2 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 the compressor motor are based on the volt-amperes of the compressor motor. The spacings at a component which controls loads in addition to the compressor 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 aforementioned loads 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 is to be used in determining the volt-ampere values.

Table 50.2
Spacings in non-refrigerated, and/or non-air handling compartments

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

NOTE – The spacings indicated are applicable only to electrical components mounted in totally enclosed nonrefrigerated and/or 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 50.1 apply.

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

50.4 With reference to 50.2 and 50.3, the spacings to enclosure are not to be applied to an individual enclosure of a component part within an outer enclosure or cabinet.

50.5 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 are to be judged on the basis of the highest voltage involved.

50.6 The above spacing requirements do not apply to the inherent spacings of a component part of the vender, such as a hermetic motor-compressor, motor, snap switch, controller, attachment-plug, 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.

50.7 An insulating lining 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) in thickness 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) in thickness 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.

50.8 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 Tests, Section 63, exceeds 500 volts, the developed potential is to be used in determining spacings for the parts affected.

50.9 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a deal 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.

51 Low-Voltage Circuits

51.1 The following electrical spacing requirements apply to low-voltage circuits, as defined in 5.25.

51.2 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 as defined in 5.25.

51.3 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 vender 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 field wiring terminals, regardless of polarity, and between the field 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 at least 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.

51.4 The spacings in low-voltage circuits which do not contain devices such as indicated in 51.3 are not specified.

52 Alternate Spacings – Clearances and Creepage Distances

52.1 Except as specified in 52.2, the spacings requirements in UL 840, are applicable as an alternative to the specified spacings requirements in the following:

a) High-Voltage Circuits, Section 50; and

b) Low-Voltage Circuits, Section 51.

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

52.3 Items (a) – (f) shall be considered when evaluating an appliance 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) Printed wiring board coating performance test of UL 840; or

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

c) Indoor use appliances are identified as pollution degree 2.

d) Outdoor use appliances 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.

52.4 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 vender.

CARBONATION SYSTEM

53 General

53.1 Parts of a carbonation system shall comply with the strength test requirements in 83.10 – 83.13.

53.2 A high-pressure regulator or reducing valve for a carbonation system shall comply with UL 252 and be provided with a vender having such a system.

53.3 A pressure-relief valve shall comply with 59.2.1 and be installed in the carbonation system. There shall be no shutoff valve between the relief valve and any parts of the carbonation system under pressure.

53.4 Pressure relief valves in a pressurized product system shall be positioned, located, or baffled so that moisture discharged through the relief valve will not wet uninsulated live parts.

PRODUCT LINES

54 General

54.1 Tubing, hoses, and fittings used for product lines operating under pressure shall comply with the Strength Tests, Section 83.

55 Thermoelectric Refrigerated Venders

55.1 A thermoelectric vender shall comply with requirements in this standard except for those specifically applying to vapor-compression refrigeration systems as specified in Sections 29.3, 56 – 59, 60.3, 69, 71, 73, 74, 82, 96, 97 and 30.1.5 – 30.1.7, 30.1.14, 63.1.3, 83.1 – 83.9, 101.4(d), 101.4(e), 101.5 – 101.8, 103.5, 103.13, 103.17 and 103.19.

55.2 Except as specified in 55.5, a thermoelectric vender in which the thermoelectric circuit is powered by:

a) An extra-low-voltage supply source shall not result in a risk of fire in accordance with 78.1.1 if no thermoelectric module cooling fan is provided or 78.1.2 if provided with thermoelectric module cooling fan(s).

b) A power source other than an extra-low-voltage supply shall not result in a risk of fire or electric shock when operated in accordance with 78.1.1 if no thermoelectric module cooling fan is provided or and 78.1.2 if provided with thermoelectric cooling fan(s). In addition, a vender shall comply with 78.1.3.

55.3 With reference to 55.2, a thermoelectric vender that uses a thermoelectric module cooling fan, other than one that is thermally protected in accordance with 29.2.1 (e), shall not develop temperatures

exceeding 302°F (150°C) on the fan motor winding (open type) or on the fan motor enclosure (enclosed type) when tested in accordance with 78.3.1.

55.4 In reference to the nonmetallic material requirements in Sections 7 – 10, a semiconductor thermoelectric module powered by other than an extra-low-voltage circuit shall be considered an ignition source.

55.5 In reference to 55.2, a thermoelectric vender not complying with 78.1.1 – 78.1.3 shall comply with 78.1.4.

REFRIGERATION SYSTEM

56 Refrigerant

56.1 A refrigerated vending machine shall not employ a refrigerant with a toxicity safety group classification exceeding Class A as described by ANSI/ASHRAE 34.

56.2 The refrigerant employed in the system shall:

a) Have flammability characteristics that have been evaluated in accordance with UL 2182; or

b) Be subjected to a compositional analysis to confirm a composition consistent with a refrigerant specified in ANSI/ASHRAE 34.

56.3 In reference to 56.2 (b), the chemical composition of the refrigerant, including the nominal composition (types and percentages) of a blended refrigerant, shall be determined by analytical testing in accordance with Section 94, Refrigerant Identification Tests, using:

a) Infrared spectroscopy for single component refrigerants; or

b) Gas chromatography for blended refrigerants.

57 Refrigerant-Containing Parts

57.1 General

57.1.1 Other than as specified in 57.1.2, parts of a vender subjected to refrigerant pressure shall withstand without failure the pressure specified in the Strength Tests, Section 83.

57.1.2 High side parts that do not comply with Strength Tests, Section 83 shall comply with the Fatigue Test in UL 207.

57.1.3 With reference to 57.1.1, if a high-side refrigerant containing part is subjected to the Fatigue Test, then the maximum abnormal or design pressure values required for this test shall be based on the maximum refrigerant pressures obtained on the refrigerant-containing part during the testing of the vender in accordance with this standard.

57.1.4 If the high-side design pressure marked on the equipment as described in 101.4 (e) equals or exceeds the critical pressure of the refrigerant, and if the Fatigue Test is conducted in accordance with 57.1.2, then the upper pressure for the high-side parts during the:

a) First cycle shall be the higher of either the equipment maximum abnormal or marked design pressure; and

b) Remaining cycles shall be not less than 95 percent of the higher of either the equipment maximum abnormal or marked design pressure.

57.1.5 With reference to 57.1.4, the lower pressure for all cycles shall not be greater than the saturated vapor pressure of the refrigerant at 40°F (4.4°C). For R744, this value is 553 psig (3.8 MPa).

57.1.6 With reference to 57.1.4, the critical pressure of R744 is 1,058 psig (7,295 kPa).

57.1.7 The parts of a vender subjected to refrigerant pressure shall be constructed of corrosion resistant material, such as copper or stainless steel, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion.

57.1.8 Pressure vessels, as referred to in this standard, are any refrigerant-containing parts other than compressors, controls, evaporators each separate section of which does not exceed 1/2 cubic foot (0.014 m^3) of refrigerant-containing volume], headers, pipe, and pipe fittings.

57.1.9 Pressure vessels over 6 inches (152 mm) inside diameter shall be constructed, tested, and stamped in accordance with the 1992 American Society of Mechanical Engineers, (ASME) Boiler and Pressure Vessel Code, Section VIII for a working pressure in compliance with the Performance section of this standard.

57.1.10 Pressure vessels bearing the ASME Code "U" symbol complying with 57.1.9 are considered acceptable without tests.

57.1.11 Pressure vessels bearing the ASME Code "UM" symbol are to be tested to determine compliance with the Strength Test, Section 83. The manufacturer is to submit evidence of compliance of these vessels with the ASME Boiler and Pressure Vessel Code, Section VIII.

57.2 Refrigerant tubing and fittings

57.2.1 Except as specified in 57.2.2, copper or steel tubing used to connect refrigerant-containing components shall have a wall thickness not less that specified in Table 57.1.

Table 57.1
Minimum wall thickness for copper, steel and aluminum tubing

Outside diameter		Copper				Steel		Aluminum	
		Protected[a]		Unprotected		Protected or unprotected[a]		Protected or unprotected[a]	
inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
3/16	(4.76)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
5/16	(7.9)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
3/8	(9.5)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
1/2	(12.7)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
5/8	(15.9)	0.0315	(0.800)	0.0315	(0.800)	0.032	(0.81)	0.0488	(1.24)
3/4	(19.1)	0.0315	(0.800)	0.0385	(0.978)	0.032	(0.81)	0.0488	(1.24)
7/8	(22.2)	0.0410	(0.0410)	0.0410	(1.041)	0.046	(1.17)	0.0650	(1.65)

NOTE – Nominal wall thickness of tubing may have to be greater than the specified thickness to maintain the minimum wall thickness.

[a] Within the product.

57.2.2 Copper or steel capillary tubing which is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 inch (0.51 mm).

57.2.3 Tubing shall be constructed of corrosion-resistant material, such as copper or stainless steel, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion.

57.2.4 Tubing shall be connected by means of flare-type fittings with steel or forged brass nuts, by soldering or brazing, or by equivalent means. Flare-type fittings shall comply with SAE J513.

57.2.5 Tubing forming part of components, such as evaporators or condensers, where protection is afforded by inherent construction, shall be judged by the Strength Test, Section 83.

57.2.6 Where a special alloy or construction is used in components that contain refrigerant, including tubing with a wall thickness less than that specified in 57.2.1, the following factors shall be considered in the investigation to determine compliance of the alloy or construction:

a) Resistance to mechanical abuse;

b) Strength with respect to internal pressure;

c) Resistance to corrosion;

d) Protection from refrigerant contamination; and

e) Compliance with applicable safety codes such as ASHRAE 15 with respect to tubing of the minimum wall thicknesses specified in 57.2.1.

58 Pressure Limiting Devices

58.1 A pressure limiting device designed to automatically stop the operation of the compressor shall:

a) Be installed on all vending machines with a system containing more than 22 pounds-mass (10 kg) of refrigerant; and

b) Comply with 30.1.14(b) and 30.1.22.

c) *Deleted*

58.2 The adjustable cutout pressure setting of a pressure-limiting device shall not exceed one-third of the ultimate strength of high-side refrigerant-containing parts provided this setting does not exceed 90 percent of the setting of the pressure relief device.

58.3 There shall be no stop valves between the pressure limiting device and the compressor.

59 Pressure Relief

59.1 General

59.1.1 Each vender shall be so constructed that pressure due to fire, or other abnormal conditions, will be safely relieved. Pressure relief devices, fusible plugs, soldered joints, or special terminals may be employed for this purpose. See 59.3.1.

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

59.1.3 A vender with a pressure vessel over 3 inch (76 mm) inside diameter, but not exceeding 3 cubic feet (0.08 m^3) internal gross volume, shall be protected by a pressure relief device or a fusible plug.

59.1.4 A vender with a pressure vessel exceeding 3 cubic feet (0.08 m^3) internal gross volume shall be protected by a pressure relief device.

59.1.5 There shall be no stop valve between the pressure relief means and the parts protected.

59.1.6 Each pressure relief device shall be connected as close as practicable or directly to the pressure vessel or parts of the system protected. They shall be connected above the liquid refrigerant level, installed so that they are readily accessible for inspection and repair, and arranged so that they cannot readily be rendered inoperative.

59.1.7 Fusible plugs may be located above or below the liquid refrigerant level.

59.2 Relief valves

59.2.1 A pressure relief valve shall comply with the Pressure Vessels Section of the ASME Boiler and Pressure Vessel Code.

59.2.2 A pressure relief valve of 1/2 inch iron pipe size (ips) or larger shall bear the authorized Code "UV" symbol together with the set pressure and capacity. A relief valve of less than 1/2 inch ips shall be similarly marked.

Exception No. 1: Where a name plate does not fit on the valve, omitting the code symbol is acceptable. If the symbol is omitted, the set pressure and capacity shall be stamped on the valve or on a metal plate attached to it.

Exception No. 2: A pressure relief valve is not required to be marked if upon investigation the valve is found to be equivalent to devices marked "UV."

59.2.3 Pressure relief valves shall be sealed at a start-to-discharge pressure not exceeding the marked working pressure of the pressure vessel protected, or not exceeding one-fifth of the ultimate strength of pressure vessels which do not have a marked working pressure.

59.2.4 The marked discharge capacity shall be not less than the minimum required discharge capacity, as specified in 59.3.1.

59.3 Fusible plugs or rupture members

59.3.1 Calculation of the minimum required discharge capacity and the rated discharge capacity of a rupture member or fusible plug shall be in accordance with ASHRAE 15.

59.3.2 Fusible plugs and rupture members shall comply with UL 207, applicable to such devices.

59.3.3 Rupture members shall have a nominal rated rupture pressure not to exceed the design pressure of the parts of the system protected.

PERFORMANCE

60 General

60.1 Test voltages

60.1.1 Unless otherwise specified, venders are to be tested with the potentials specified in Table 60.1, maintained at the unit supply connections.

Table 60.1
Test voltages

Nameplate Voltage Rating	Normal Test voltage[a]	Overvoltage	Undervoltage
110 to 120	120	132	102
208	208	229	177
220 to 240	240	264	204
254 to 277	277	–	–
440 to 480	480	528	408
550 to 600	600	660	510
Other	Rated	110 percent rated	85 percent rated

[a] These test voltages are nominal for the Condenser Fan Motor Failure Test and the Water Failure Test.

60.2 Temperature measurements

60.2.1 Temperatures are to be measured using thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to comply with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in ASTM E230/E230M.

Exception: When the temperature of a coil or motor winding is not obtainable using the thermocouple measurement method (e. g. encapsulated coils), the change-of-resistance method is to be used. See 63.1.4.

60.2.2 Each thermocouple junction and adjacent thermocouple lead wires are to be securely held in positive thermal contact with the surface of the material whose temperature is being measured. In most cases, thermal contact will result from securely taping or cementing the thermocouple in place, but where a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

60.2.3 If thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, it is a standard practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type of indicating instrument. This equipment will be used whenever referee temperature measurements by means of thermocouples are necessary.

60.2.4 Except as specified in 60.2.5, 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.

60.2.5 In reference to 60.2.4, 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.

60.2.6 In reference to 60.2.4 and 60.2.5, the recorded temperature shall be the highest of the three readings.

60.3 Pressure measurements

60.3.1 A pressure gauge is to be attached in such manner as to prevent leakage. Special fittings for direct connection to the system or minimum lengths of 1/8 inch (3.2 mm) outside diameter commercial capillary tubing may be employed for gauge connections. The volume of the pressure-measuring gauge and lines is to be held to a minimum. All joints in the gauge system are to be tested for leakage.

60.3.2 Opening of the gauge line valves shall not cause a significant change in the electrical input of the system. High-side gauges and lines may be heated above the saturation temperature corresponding to the expected pressure or may be precharged with a liquid refrigerant of the same type as used in the system to minimize the effect of opening the gauge line valves.

61 Leakage Current Test

61.1 The leakage current of a cord connected vender rated for a nominal 120 volt supply employing a standard attachment-plug rated 15 or 20 amperes, Designation 5-15P or 5-20P, when tested in accordance with 61.6 and 61.7 shall be no more than 0.75 milliamperes.

Exception: Refrigerated venders are not required to comply with 61.1 if they comply with UL 101.

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

61.3 Each exposed conductive surface is to be tested for leakage currents. The leakage currents from each surface is 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 suitable for protection against risk of electric shock as defined in 13.3.13 – 13.3.17. Surfaces are considered to be simultaneously accessible when 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 which are considered to be low-voltage as defined in 5.20.

61.4 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 3.9- by 7.8-inches (10- by 20-cm) in contact with the surface. If the surface is less than 3.9- by 7.8-inches (10- by 20-cm), the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the vender.

61.5 The measurement circuit for leakage current shall be as shown in Figure 61.1. The measurement instrument is defined in (a) – (c) and, unless it is being used to measure leakage from one part of the vender to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

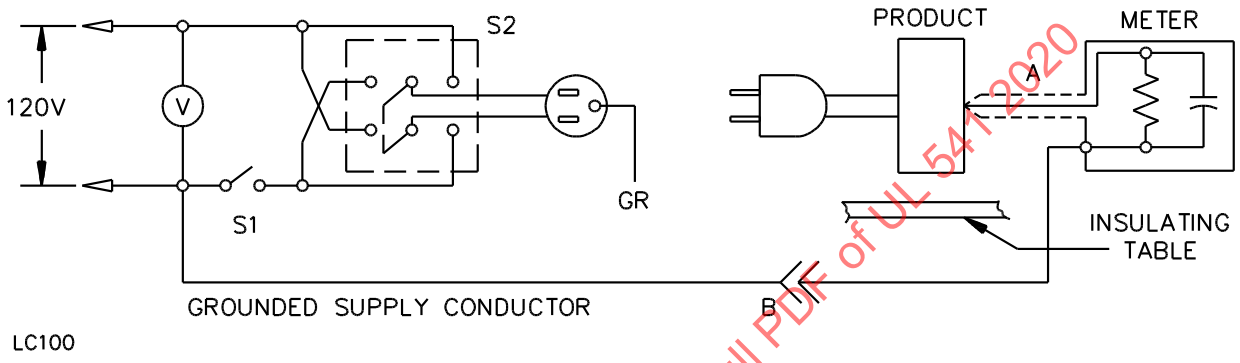
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

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 milliampere, the measurement is to have an error of not more than 5 percent.

Figure 61.1

Leakage current measurement circuit



Note:

A Probe with shielded lead.

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

61.6 A sample vender 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, installation, and the like, of the production unit.

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

c) The sample is to be conditioned in an ambient temperature of 21.1 – 26.7°C (70 – 80°F) and 50± 5 percent relative humidity for not less than 8 hours.

d) The test is to be conducted at the ambient conditions specified by item c)

e) The supply voltage is to be adjusted to 120 volts.

f) A vender which requires connection to a potable water supply, such as a carbonated drink vender, is to be filled with water.

g) A water-cooled vender is to be tested with water flowing through the condenser at a rate adequate for intended operation.

61.7 The leakage current test sequence, with reference to the measuring circuit Figure 61.1 is to be as follows. If during any of the following tests, the compressor stalls during positioning of switch S2, the test is to be conducted in its entirety in one polarity. The polarity is then to be reversed and the test repeated.

a) With switch S1 open, the vender 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 then to be operated in their intended manner, and leakage currents measured using both positions of switch S2.

b) With the vender switching devices in their intended operating position, switch S1 is then to be closed, energizing the vender, and within a period of 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 intended manner, and leakage currents measured using both positions of switch S2.

c) The vender manual switching devices are then to be returned to their intended operating positions and the unit allowed to run until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test thermal equilibrium is defined as that condition where 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 cooling and vending mode. This cycling is to be observed in both positions of switch S2.

d) Immediately following the above test, any single pole switch or thermostat in the vender is to be opened, and the leakage current monitored until constant or decreasing values of leakage current are recorded. Readings are to be taken in both positions of switch S2.

62 Input Test

62.1 The measured ampere input to a vender shall not exceed the total rating (s) marked on the nameplate by more than 10 percent when tested as described in the Temperature and Pressure Tests, Section 63.

Exception: For a battery-operated vender, the input is to be measured with the vender in the charging mode during the Temperature and Pressure Test 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.

62.2 The measured ampere input employed in applying this requirement to a nonautomatic vender is the input measured during an operating cycle. See 63.1.12. For an automatic vender, the measured ampere input is the total of the input measured during an operating cycle plus the input to the vending mechanism. Any loads that may occur concurrently during the test sequence may be determined individually. The maximum ampere input to the vender is considered to be the largest total of all individual loads that may occur concurrently. The power input of all accessories is to be included when establishing the minimum marked rating of the vender if the accessories derive power from the vender.

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

63 Temperature and Pressure Tests

63.1 General

63.1.1 The temperature rises measured on the electrical components of a vender tested as described in 63.1.4 – 63.1.12 shall not exceed those specified in Table 63.1.

63.1.2 The temperature of relay insulating materials and coils shall not exceed the temperature limitations specified in Table 63.1 when tested as described in 63.1.4 – 63.1.12.

63.1.3 The maximum pressure in the refrigeration system is to be used as a basis for the Strength Test, Section 83 requirements.

Table 63.1
Maximum temperature rises

Device or material	°C	°F
A. Motors		
1. Insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including hermetic motor-compressors)[a,b]		
Class A insulation systems		
a. In open motors –		
Thermocouple or resistance method	75	135
b. In totally enclosed motors–		
Thermocouple or resistance method	80	144
Class B insulation systems		
a. In open motors –		
Thermocouple or resistance method	95	171
b. In totally enclosed motors–		
Thermocouple or resistance method	100	180
2.Insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) (not including hermetic motor-compressors)[a,b]		
Class A insulation systems		
a. In open motors –		
Thermocouple method	65	117
resistance method	75	135
b. In totally enclosed motors –		
Thermocouple method	70	126
resistance method	80	144
Class B insulation systems		
a. In open motors –		
Thermocouple method	85	153
resistance method	95	171
b. In totally enclosed motors –		
Thermocouple method	90	162
resistance method	100	180
B. Components		
1. Capacitors		
a. Electrolytic type[d]	40	72
b. Other types[e]	65	117
2. Field wiring	35	63
3. Fuse bodies	65	117

Table 63.1 Continued on Next Page

Table 63.1 Continued

Device or material	°C	°F
4. Hermetic motor-compressor enclosure	150[c]	302[c]
5. Relay, solenoid, and other coils with[b]		
a. Class 105 insulated winding –		
Thermocouple method	65	117
Resistance method	85	153
b. Class 130 insulation –		
Thermocouple method	85	153
Resistance method	105	189
6. Solid contacts	65	117
7. Transformer enclosures – with		
a. Class 2 transformers	60	108
b. Power transformers	65	117
8. Transformer windings		
a. Class 105 insulation		
Thermocouple method	65	117
Resistance method	85	153
b. Class 130 insulation –		
Thermocouple method	85	153
Resistance method	105	189
c. Class 155 insulation;		
Class 2 transformers –		
Thermocouple method	95	171
Resistance method	115	207
Power transformers –		
Thermocouple method	110	198
Resistance method	115	207
d. Class 180 insulation;		
Class 2 transformers –		
Thermocouple method	115	207
Resistance method	135	243
Power transformers –		
Thermocouple method	125	225
Resistance method	135	243
9. Wood or other combustible material	65	117
C. Insulated conductors[f]		
1. Flexible cords and wires with rubber, thermoplastic, or neoprene insulation unless recognized as having special heat-resistant properties as follows:		
Temperature rating –		
°C °F		
60 140	35	63
75 167	50	90
90 194	65	117
105 221	80	144
D. Electrical insulation		

Table 63.1 Continued on Next Page

Table 63.1 Continued

Device or material		°C	°F
1. Fiber used as electrical insulation or cord bushings		65	117
2. Phenolic composition used as electrical insulation or as parts where failure will result in a hazardous condition[f]		125	225
3. Thermoplastic material.[f] Rise based on temperature limits of material as follows:			
Temperature rating –			
°C	°F		
60	140	35	63
75	167	50	90
90	194	65	117
105	221	80	144

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

[b] If the coil is inaccessible for mounting thermocouples (for example, a coil immersed in sealing compound) or if the coil wrap includes thermal insulation or more than two layers, 1/32 inch (0.8 mm) maximum, of cotton, paper, rayon, or the like, the change-in-resistance method is to be used. For a thermocouple measured temperature of a coil of an alternating-current motor, other than a hermetic motor compressor having a diameter of 7 inches (178 mm) or less, the thermocouple is to be mounted on the integrally applied insulation on the conductor. At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by a thermocouple may be (not including hermetic motor compressors) more than the indicated maximum provided that the temperature rise of the coil, as measured by the resistance method is not more than that specified in the table:

1. Insulation on coil windings of alternating-current motors having a diameter of 7 inches (178 mm) or less, open type, not including hermetic motor compressors,

5°C (9°F) for Class A insulation

10°C (18°F) for Class B insulation

2. Insulation on coil windings of alternating-current motors having a diameter of more than 7 inches (178 mm), open type, not including hermetic motor compressors,

15°C (27°F) for Class A insulation

20°C (36°F) for Class B insulation

[c] Maximum – not rise: for the exposed surface of the motor-compressor enclosure, including the surface of a wrap-around crankcase heater.

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

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

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

63.1.4 A representative vender is to be prepared for test in the following manner. Pressure gauges are to be installed on the high- and low-sides of the refrigeration system. Thermocouples are to be secured to electrical components, including compressor motor enclosure, fan motor windings, the coils of all relays, solenoids, and electrically operated valves, capacitors, transformers, wiring insulation, insulating material, and to flammable material which may be heated in the tests. Accessories intended for use with the vender are to be installed in or on the vender according to the manufacturer's instructions. Thermocouples are to be secured to the electrical components of accessories and to insulated wire connectors, connector bodies, and the like, used to connect the accessory to the vender. The temperature of motor windings or of coils may be measured by the resistance method, but the primary method of temperature measurements is to be the thermocouple method. Removable air baffles, shrouds, and the like, are to be in place.

63.1.5 The vender is to be filled with the quantity and size of product (or representative facsimile) specified by the manufacturer, except that venders intended to handle prefrozen products are to be tested with no product load. Bottles, cans, or cartons may contain the beverage or water.

63.1.6 A cup-drink vender is to be charged with the beverage or ingredients as specified by the manufacturer. Water may be employed instead of the beverage or ingredients. If a carbonation system is used, it is to be connected to a water supply controlled to deliver 26.7°C (80°F) water. The water tank is to be filled.

63.1.7 The refrigeration controller is to be electrically bypassed or shunted to provide continuous operation during pulldown. Light switches, other than the switch for a service light, are to be placed in the ON position.

63.1.8 The vender, with door or lid open, is to be placed in a room maintained at 40°C (104°F) until the assembly and contents, if any, reach room temperature.

63.1.9 For water-cooled units, condenser inlet and outlet water temperatures are to be maintained at 26.7 and 37.8°C (80 and 100°F), respectively.

63.1.10 The vender is to be started and operated with the door or lid closed. The potential is to be maintained as indicated in 60.1.1.

63.1.11 PULLDOWN – The unit is to be operated until temperatures on electrical components have stabilized. The temperatures, pressures, and input are to be recorded at intervals. The vender is to pull down without tripping manual reset protective devices. An automatic reset protective device may cycle provided pulldown is obtained within an 8 hour period. Pulldown will be effected when the unit runs as intended at approximately constant current input and low-side pressure.

63.1.12 READY-TO-VEND – The refrigeration controller is to be restored to the circuit, and the vender permitted to cycle several times by operation of this control. The maximum input during an operating cycle is to be determined.

63.2 Automatic venders

63.2.1 An automatic vender is to be additionally tested as detailed in 63.2.2 – 63.2.5.

63.2.2 VENDING – The vender is to be operated through 100 vending cycles, or the full capacity of the machine if the vending capacity is less than 100 cycles. For multiple-selection machines, one vending stack or shelf is to be completely emptied before proceeding to another selection when accumulating 100 vending cycles. The vender is to be operated at 10 second intervals unless a slower rate is required by the machine. The maximum temperatures and the electrical input to the vending mechanism are to be recorded.

63.2.3 SOLD OUT – Controls are to be placed in the sold out or empty position, and the vender is to be energized until temperatures have stabilized. The maximum temperatures and electrical input are to be recorded.

63.2.4 With reference to 63.2.2 and 63.2.3, the temperature and the electrical input of the components in the vending circuit and lighting circuit can be determined in any convenient ambient temperature. The input current determined under this condition may be added to that recorded under pulldown and ready-to-vend conditions to determine the total maximum input to the vender if such loads operate concurrently.

63.2.5 The assembly is to be subjected to the Dielectric Voltage Withstand Test, Section 64, following the above tests.

64 Dielectric Voltage-Withstand Test

64.1 A vender shall withstand for a period of 1 minute, without breakdown, the application of a test potential between high-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 a capacitor exceeds 500 V, as measured during the temperature and pressure 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 99.1, Condition A and applied for 1 minute.

64.2 A vender employing a low-voltage circuit shall be capable of withstanding, for 1 minute, without breakdown, the specified test potential applied between low-voltage live parts of opposite polarity and 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.

64.3 In reference to 64.2, if components specified in 51.3 are employed in the low-voltage circuit, the dielectric voltage-withstand test shall be:

a) 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.

64.4 With reference to 64.3, 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.

64.5 A 500 volt-ampere or larger transformer with a regulated output voltage is to be used to determine compliance with the foregoing. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that 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.

64.6 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 64.5.

64.7 The capacitors and capacitor-type filters mentioned in 64.6 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.

64.8 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.

65 Heating Test

65.1 If required in accordance with 26.2.14 or 40.2, the test in 65.2 – 65.3 shall be conducted on a vender equipped with an electric resistance heating element or an electric-discharge lighting system. Temperatures shall not exceed:

a) 194°F (90°C) on the coil of an open-type ballast and on the enclosure of an enclosed reactor-type ballast or other control device employed in an electric-discharge lamp system;

b) 176°F (80°C) on the enclosure of an automatic starter; or

c) The temperature limits in Table 63.1 for other components.

65.2 The test is to be conducted with the ballasts lighting loads and electric heating elements installed in a complete vender, or a representative section thereof.

65.3 The ballast, lighting, loads, and heating elements are to be connected to a supply circuit having a power supply maintained at the voltage specified on the control equipment. The test ambient is to be 77 ± 3° F (25 ±2° C). Thermocouples are to be attached to open coils, ballast enclosures, wiring, and other components specified in Table 63.1. The test is to be continued until components reach constant temperatures. The refrigeration system is to be deenergized during this test.

66 Insulation Resistance Test

66.1 A vender employing insulating material likely to be affected adversely by moisture under conditions of use shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 32±2°C (90 ±4°F).

67 Rain Test

67.1 A vender intended for use in protected or outdoor locations shall be subjected to a rain exposure without creating a risk of electric shock due to current leakage or insulation breakdown.

67.2 The vender, after exposure, shall have an insulation resistance between current carrying parts and noncurrent carrying parts of not less than 50,000 ohms, and shall withstand, without breakdown, the voltage indicated in the Dielectric Voltage Withstand Test, Section 64. The test shall not result in the wetting of uninsulated live parts, except that motor windings may be judged by the Insulation Resistance Test, Section 66 and Dielectric Voltage Withstand Test, Section 64, provided the motors are constructed, located, or shielded so that the windings are not directly exposed to water in the Rain Test.

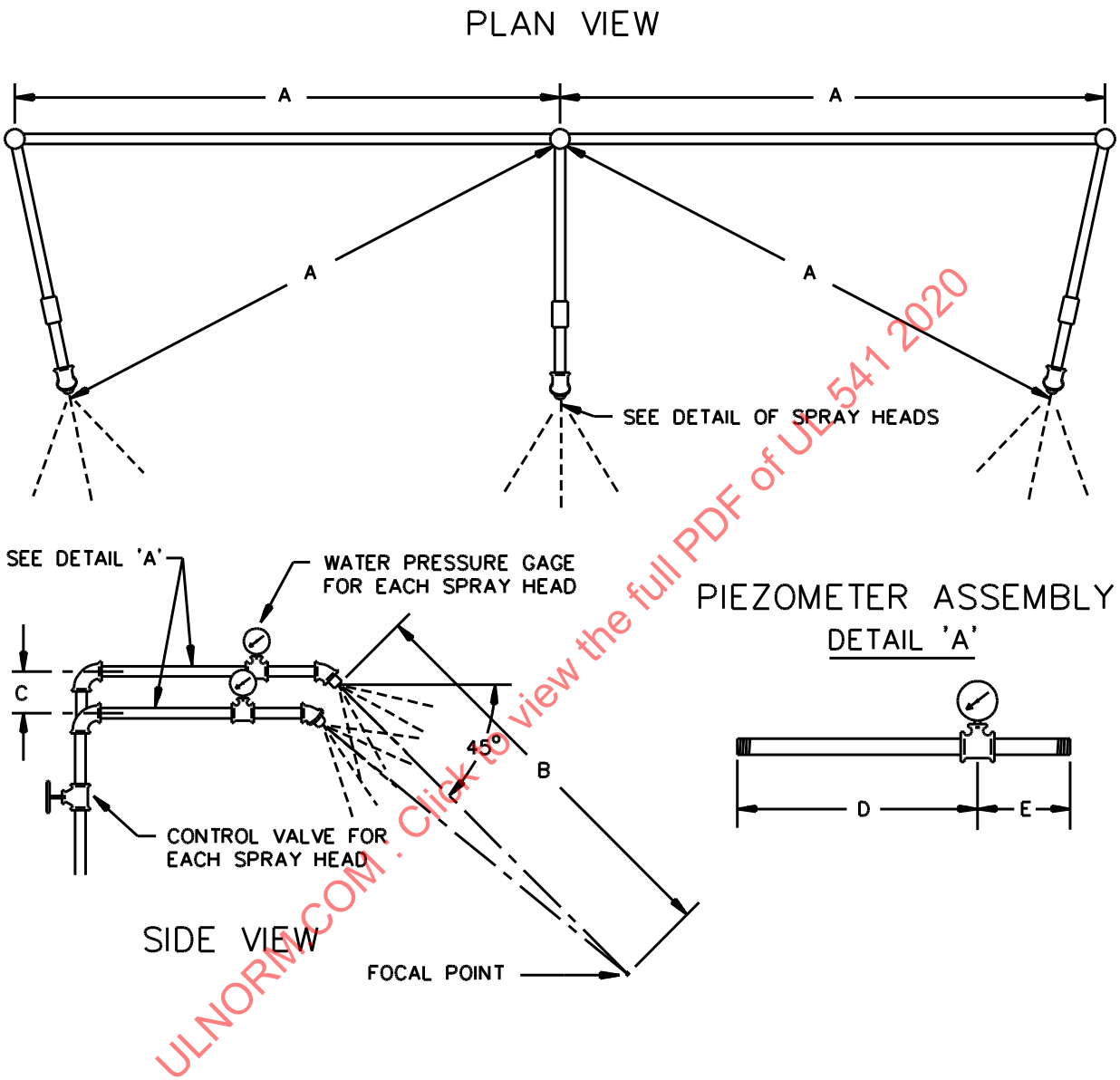
67.3 The vender is to be positioned and leveled in accordance with the manufacturer's instructions. A vender intended for use in protected locations is to be provided with a representative shelter, such as a roof, canopy, marquee, or the like, which is to be positioned over the vender in accordance with the manufacturer's instructions. A vender intended for outdoor use is tested without a shelter. The insulation resistance of the vender is to be measured before the test by the series-voltmeter or other suitable method. The insulation resistance is to be at least than 50,000 ohms before the test.

67.4 The rain test apparatus is to consist of three spray heads mounted in a water-supply pipe rack as shown in Figure 67.1. Spray heads are to be constructed in accordance with the details shown in Figure

67.2. The water pressure for each test is to be maintained at 5 psig (34 kPa) at each spray head. The vender or shelter or both, is to be centrally located within the spray pattern under conditions most likely to cause entrance of water into or on the electrical components. The spray is to be directed toward openings in the shelter and/or openings in the cabinet, door, and gasketed covers and panels, including the door. The distance between the center nozzle and the vender and/or shelter is to be approximately 3 feet (0.91 m); however, since the overall size of venders varies, it may be necessary to make slight adjustments in the position of the nozzles to allow the greatest quantity of water to enter openings in the vender and/or shelter.

Figure 67.1

Rain-test spray-head piping

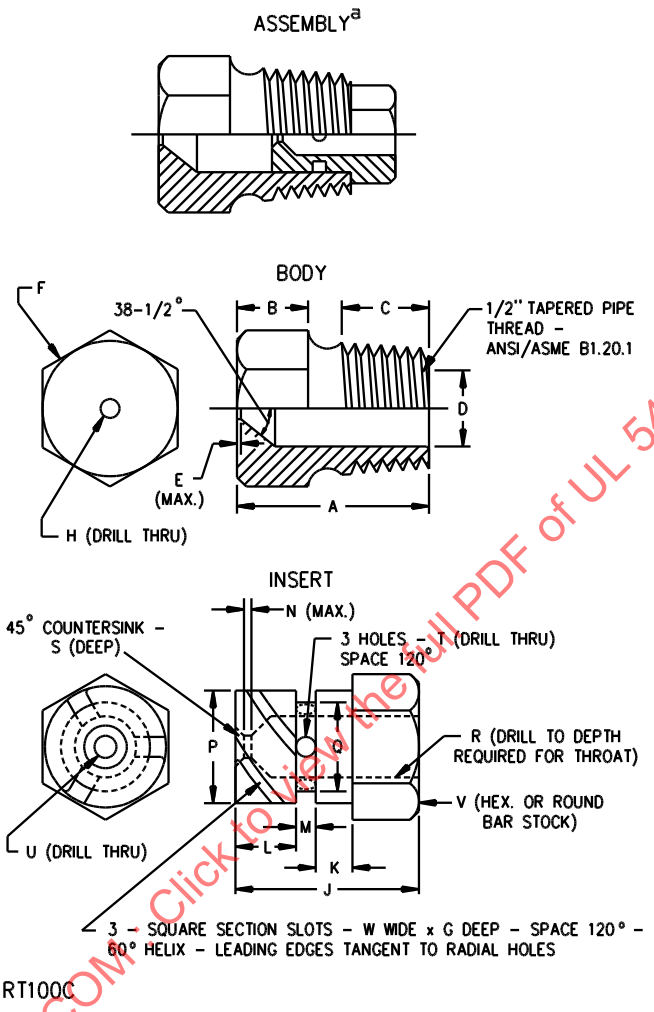


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101D

Figure 67.2

Rain-test spray head



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]	2.80
H	(No. 9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97		0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain – Test Spray Heads are available from Underwriters Laboratories Inc.

[b] ANSI B94.11M Drill size.

[c] Optional – To serve as wrench grip.

67.5 The test is to be continued for a total of 1 hour, during which time the vender is to be running so that electrical components located in vulnerable areas are energized. If it is evident that certain conditions, such as condenser air flow, position of vender under water spray, and the like, may affect the results the test is to be repeated with the vender subjected to these other conditions. Upon completion of the test(s), the insulation resistance is to be measured; after which the sample is to be tested in accordance with the Dielectric Voltage Withstand Test, Section 64.

68 Stability Test

68.1 A vender shall be stable and not overturn when tested as described in 68.2 – 68.5. A vender having a supporting base such that both the width and depth dimensions are greater than the height is considered to comply with the requirement.

68.2 The vender is to be supported by the legs, leveling screws, or casters provided in the base of the unit. Accessories which are intended for use with the vender are to be installed. Swivel-type casters, if any, are to be oriented so that the tendency to overturn is maximum. Plumbing connections or conduit connections are not to be relied on during the test. The vender shall not overturn under the following conditions:

a) A vender, with service doors, covers, and panels closed, is to be placed on a plane surface inclined at an angle at 10 degrees with the horizontal. The vender is to be tested with no product load, with half load, and fully loaded. Under half-load conditions, the product is to be arranged in the vender so that the tendency of the vender to overturn is maximum. If different products are intended to be vended from the same machine, the machine is to be tested with the product so that the tendency of the vendor to overturn is maximum.

Exception: This test is not required on a vender which is intended to be secured to a wall, pillar, floor or other permanent part of a building structure.

b) An empty vender, is to be placed on a horizontal surface. If leveling screws are provided, they are to be adjusted equally to raise the vender 1 inch (25.4 mm) above floor level. 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 with the cabinet. If it is necessary to open more than one door to gain access to the product storage compartment, all such doors are to be opened. Any subassembly, such as a cup dispenser, which swings out of the cabinet for servicing, is to be positioned so that the tendency of the vender to overturn is maximum. If more than one such subassembly is provided, the one which provides the most severe unbalanced condition is used during this test.

Exception: This test is not required on a vender which remains secured to a wall, pillar, floor or other permanent part of a building structure when the main service door(s) is opened as described above.

68.3 If required for compliance with 68.2(b), a leg, brace or similar support provided in the vender door shall be fixed in position or shall operate automatically to position itself when the door is opened, and shall be designed so that its intended function cannot be readily defeated. See 101.10. A leg, brace or similar support may not be required if the bottom of the door is close enough to the floor to prevent the vender from overturning under the conditions described in 68.2(b) and also when the door, loaded as described above, is in any position between closed and fully opened as permitted by door restraints which may be used.

68.4 The manufacturer's instructions shall be used to install the vender for tests to judge conformance to 68.3. All adjustments of door support means shall be made in accordance with the directions included with the machine. After the initial installation procedure is completed, no further adjustments are to be made.

68.5 Unique mounting or support systems for venders which would require securing to a wall or other support surface shall be separately evaluated to determine their reliability, ease of operation, and likelihood of continued use.

69 Condenser Fan Motor Failure Test

69.1 A vender shall not be exposed to hazardous pressure or temperature, or leak refrigerant if the condenser fan motor locks or fails to start.

69.2 The requirement in 69.1 will be complied with if:

a) The refrigeration system does not rupture or develop leaks during the test. The maximum high- and low-side pressures are to be recorded as reference values for the Strength Tests, Section 83, requirements. An assembly employing a pressure-limiting device conforming with 58.2, as applicable, is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure of the fan motor winding (open type) or of the fan motor enclosure (enclosed type) does not exceed 150°C (302°F). Compressors and condenser fan motors equipped with thermal protective devices as specified in 29.2.1 (c) and 29.3.1(b) are considered to comply with this requirement.

69.3 A sample of the assembly is to be fitted with a pressure gauge on the high pressure side of the refrigeration system and provided with thermocouples on the compressor motor enclosure and condenser fan motor winding (open type) or condenser fan motor enclosure (enclosed type). When evaluating low side components for compliance with the strength requirements of 83.4 a pressure gauge is to be fitted on the low side of the system. The low side pressure is to be recorded while the compressor is operating and after shutdown. If the vender is provided with means to relieve discharge pressure into the low side of the system, the low side pressure is to be recorded while:

a) The compressor is operating, the pressure relief means is open and the low side pressure is increasing; and

b) After shutdown of the compressor.

69.4 The controls are to be set for maximum cooling and the vender is to be operated with the condenser fan motor locked until stabilized temperatures and pressures are reached. The compressor motor overload device and/or the fan motor overload device may operate during this test. The test ambient is to be approximately 25°C (77°F). The potential is to be maintained as indicated in 60.1.1. Where two or more condenser fan motors are employed, the test is to be conducted with one motor locked.

70 Antitheft Device Test

70.1 A vender shall not dispense a free product, including coins, when tipped from its normal vertical position.

70.2 The vender is to be tipped to any position deemed appropriate in an effort to obtain a free product or coins. The vender may be rocked back and forth through several cycles in any of these positions to determine if a free product or coin will be dispensed.

71 Water Failure Test

71.1 A water-cooled vender without a pressure-limiting device shall not be exposed to excessive pressures during water failure.

71.2 Pressures shall not exceed those permitted by 83.1.

71.3 The vender is to be connected to an equivalently rated circuit. The test ambient is to be approximately 25°C (77°F). A pressure gauge is to be connected on the high-pressure side.

71.4 A sample of the assembly is to be fitted with a pressure gauge on the high pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure. When evaluating low side components for compliance with the strength requirements of 83.4 a pressure gauge is to be fitted on the low side of the system. The low side pressure is to be recorded as specified in 69.3. The unit is to be operated with the condensing water shut off and also with the condensing water restricted until maximum pressures and stabilized temperatures are reached or until representative maximum temperatures and pressures are attained under cycling load. If the unit cycles on the motor overload protective device, the test is to continue until the maximum pressure during the protective device operation is obtained. The room ambient is to be approximately 25°C (77°F). The potential is to be maintained as indicated in 60.1.1.

71.5 The test need not be conducted to determine compliance with 71.1 if a pressure limiting device is provided. The maximum cutout pressure to which the pressure limiting device may be readily adjusted by the adjusting means provided shall be employed in determining compliance with 71.2. See 83.1.

72 Start-To-Discharge Test

72.1 Each pressure-relief device used in the carbonation system is to be tested to determine the pressure at which the device will open and start to discharge. A pressure-relief device which is part of a component and which has been subjected to this test is exempt from this requirement.

72.2 Three samples of the device are to be tested. Each sample is to be connected to a gas source, such as nitrogen, and immersed in water. The pressure is to be gradually increased until the device starts to discharge as evidenced by the occurrence of bubbles in the water. The average of three readings for each of three representative samples is to be used to determine the start-to-discharge pressure.

73 Rupture Member Test

73.1 A rupture member shall burst at a pressure within 5 percent of its nominal rated rupture pressure. The nominal rated rupture pressure is considered to be the average sum of the minimum and maximum marked bursting pressures.

73.2 Three samples of each size are to be tested as follows. Each sample is to be connected to a gas source, such as air, carbon dioxide, or nitrogen, but oxygen or any flammable gas is not to be used. The pressure is to be increased until rupture occurs. The rate of pressure increase is to be not faster than 5 percent of the minimum marked bursting pressure per minute after the pressure reaches 90 percent of the minimum marked bursting pressure.

74 Fusible Plug Test

74.1 A fusible plug shall function within 5.6°C (10°F) of its marked temperature rating.

74.2 Three samples of each size are to be tested. Each sample is to be attached to a 10-foot (3 m) length of coiled copper tubing within which air pressure of not less than 40 psig (275 kPa) is maintained. The coil and test sample are to be immersed in a fluid, the temperature of which is 11.1°C (20°F) below the marked temperature of the plug. After 5 minutes, the temperature is to be increased at the rate of 0.5°C (1°F) per minute. The relief temperature is considered to be that temperature at which the test pressure is relieved and complete blowout of the fusible element occurs.

74.3 A blowout is considered complete if the area of the relief opening is such that the resulting discharge capacity complies with the requirements in 59.3.1.

75 Overload and Endurance Test – Switching Devices

75.1 A switching device in a vender shall perform acceptably when tested as follows for overload and endurance, with no electrical or mechanical failure nor undue burning, pitting of contacts, or striking for an arc to the enclosure.

75.2 This test need not be conducted on refrigeration controllers, starting relays, motor protectors, temperature- or pressure-limit switches, or on switching devices having a rating suitable for the load controlled.

75.3 The tests on switching devices are to be conducted by operating the vending and coin or credit mechanisms using the normal loads of the vender if practicable. Switching devices which are not operated in this test are to be cycled individually or collectively while controlling the loads indicated in 75.4 – 75.8.

75.4 The switching device is to be mounted and subjected to the ambient temperature as intended in service. The test cycle is to be 1 second ON and 9 seconds OFF unless a slower rate is required by the design of the vender. A faster rate may be used if agreeable to all concerned.

75.5 A switching device intended for controlling a noninductive load shall be capable of performing acceptably when subjected to an overload test consisting of making and breaking for 50 cycles of operation, at a rate of 6 cycles per minute, a current of 150 percent of the connected load, at the voltage indicated in 60.1.1.

75.6 A switching device intended for controlling a single motor load or a combination of motor(s) and other loads shall perform acceptably when subjected to an overload test consisting of making and breaking the load described in 30.1.8 for 50 cycles of operation, at a rate of 6 cycles per minute, when connected to a voltage supply as indicated in 60.1.1.

75.7 A switching device intended for controlling a pilot-duty load shall perform acceptably when subjected to an overload test consisting of making and breaking for 50 cycles of operation, at a rate of 6 cycles per minute, a current equal to the connected load, at 110 percent of the voltage indicated in 60.1.1.

75.8 In addition to the tests described in 75.5, 75.6, or 75.7, a switching device shall be capable of performing acceptably when subjected to an endurance test consisting of making and breaking 100 percent of the connected load current. The endurance test voltage supply shall be as indicated in 60.1.1 and the cycling shall consist of making and breaking the connected load for:

a) 6000 cycles of operation with 1 second ON and 9 seconds OFF for a switching device other than one used to control a motor-compressor; or

b) 24,000 cycles of operation with 1 second ON and 9 seconds OFF followed by 6,000 cycles of operation with 1 second ON and 59 seconds OFF for a switching device used to control a motor-compressor.

75.9 The power factor of an inductive load is to be 0.75 – 0.80; except that it is to be 0.40 – 0.50 for a load simulating locked-rotor conditions in a motor, and is not to be more than 0.35 for a pilot-duty load.

75.10 For a grounded-neutral system, the enclosure of the vender is to be connected during the endurance test through a 30 ampere cartridge fuse to the grounded conductor of the circuit. For any other system, the enclosure is to be connected through such a fuse to the live pole least likely to strike (arc) to ground.

75.11 The switching device is to be subjected to the Dielectric voltage Withstand Test, Section 64, following the above tests.

76 Burnout Tests – Components

76.1 General

76.1.1 A vender shall not present a risk of fire or electric shock when operated under the conditions described in 76.1.2 – 76.3.2, which may occur in service.

a) A risk of fire is considered to exist if there is any emission of flame or molten metal from the vender, or glowing or flaming of flammable material. Blowing of the supply-circuit fuse is acceptable if a risk of fire does not exist.

b) A risk of electric shock is considered to exist if the insulation resistance of the vender is less than 50,000 ohms.

76.1.2 To determine if a risk of fire or electric shock exists, a burnout test is to be conducted on components, such as an intermittent-duty relay, solenoid, electrically-operated valve, or the like, that the construction of the vender indicates may present a risk of fire or electric shock. The tests should be made with the component installed as intended in the vender. The vender is to be connected to a supply circuit maintained as indicated in 60.1.1. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating that may be used. For cord connected venders, the supply circuit fuses are to correspond in size to the rating of the attachment plug, except that 20 amperes is the minimum size for venders rated 150 volts or less.

76.1.3 Malfunction of a single component resulting in an intermittent-duty relay or solenoid being continuously energized shall not cause a risk of fire or electric shock. The test is to be conducted with the relay or solenoid continuously energized until the ultimate result is determined.

76.1.4 If a relay or solenoid fails to operate at 15 percent below rated voltage as required by 80.1, a risk of fire or electric shock shall not result.

76.1.5 The relay or solenoid is to be energized while blocked in its inoperative position from a supply source maintained as indicated in 60.1.1 until the ultimate result is determined.

76.2 Electrically operated valves

76.2.1 Each electrically operated valve or solenoid shall comply with the requirements of the Burnout Test.

76.2.2 If an electrically operated valve or solenoid becomes blocked in the de-energized position, a risk of fire or electric shock shall not result.

76.2.3 The valve mechanism is to be blocked in the position assumed when the valve is de-energized, and the valve then is to be energized continuously until the ultimate result is determined.

76.3 Liquid-level system

76.3.1 If, in a vender liquid-level system, malfunction of a relay may overload a transformer or other part of the system, a risk of fire or electric shock shall not result.

76.3.2 In this test, the liquid-level system is energized with the relay armature blocked until the ultimate result is determined.

77 Burnout Test – High-Voltage Transformers

77.1 There shall be no emission of flame or molten metal from the vender enclosure when a high-voltage transformer is operated under the conditions described in 77.2 and 77.3.

Exception: This test does not apply to a high-voltage transformer that is provided with thermal overload protection of other than the nonrenewable thermal cutoff type (see 31.1.7) or that is protected by an overcurrent device(s) in accordance with the requirements in 31.2.1.

77.2 Three samples of the transformer are to be operated continuously at the normal test voltage indicated in Table 60.1 and rated frequency with the enclosure grounded. The test ambient temperature is to be approximately 25°C (77°F) and operation is to be continued until constant temperature is indicated by a thermocouple on the enclosure or until burnout occurs. The circuit on which the transformer is tested is to be protected by fuses rated not less than that required for the vendor.

77.3 The load connected to the output terminals is to be the highest of the values specified in (a) – (c) and is to be readjusted to the specified value after 2 minutes of operation, if necessary, with no further readjustment during the test.

a) A resistance load to provide a current equal to three times the full rated transformer secondary current;

b) If the transformer supplies a motor with or without additional loads, a resistance load to provide a current equal to the motor locked-rotor current plus any additional loads; or

c) If the transformer supplies an inductive load (other than a motor), such as the coils of relays, solenoids, and the like, a resistance load to provide a current equal to the sum of such loads with the armature of the largest blocked open.

Exception: The test may be conducted with the output terminals short-circuited if this results in less than three times rated secondary current.

78 Abnormal Tests – Thermoelectric Refrigerated Venders

78.1 General

78.1.1 Except as specified in 78.1.4, a thermoelectric vender without a thermoelectric module cooling fan, when tested in accordance with 78.2.1 shall not:

a) Emit any flame or molten metal from the vender; or

b) Show any evidence of any glowing or flammable material within the vender.

78.1.2 Except as specified in 78.1.4, a thermoelectric vender with thermoelectric module cooling fan(s), when tested in accordance with 78.3.1 shall not:

a) Emit any flame or molten metal from the vender;

b) Show any evidence of any glowing or flammable material within the vender; or

c) Develop temperatures exceeding 302°F (150°C) on the fan motor winding of an open type motor or of the fan motor enclosure of an enclosed motor.

78.1.3 Except as specified in 78.1.4, a thermoelectric vender with a semiconductor thermoelectric module powered by other than an extra-low-voltage circuit shall comply with 78.4.1. No dielectric breakdown shall occur.

78.1.4 If the tests specified in 78.1.1– 78.1.3 are not conducted, the Dielectric-Voltage Withstand – 5000 Volt Test, Section 78.5 shall be performed. No dielectric breakdown shall occur.

78.2 Thermoelectric venders without cooling fans

78.2.1 Unless tested in accordance with 78.1.4, a thermoelectric vender without a semiconductor thermoelectric module cooling fan is to be connected to a supply circuit maintained as specified in Test Voltages, Section 60.1. Any heat sink on the hot side of the thermoelectric module is to be removed, but any fuses within the thermoelectric circuit are to remain. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating intended to be used in the branch circuit supply. For cord connected venders, the fuses are to correspond in size to the rating of the attachment plug, except that 20 amperes is the minimum size for venders rated 120 volts or less. The vender is to be operated for not less than 7 hours until fuses open or burnout of the thermoelectric module occurs. The vender shall comply with 78.1.1(a) and (b).

78.3 Thermoelectric venders with cooling fans

78.3.1 Unless tested in accordance with 78.1.4, a thermoelectric vender that uses a fan, other than a motor that is thermally protected in accordance with 29.2.1(e), to cool the thermoelectric module shall be connected to a supply circuit maintained as specified in Test Voltages, Section 60.1. The thermoelectric module cooling fan motor is to be electrically energized but with the fan locked to prevent turning. If multiple fans are provided, only one fan is to be locked. The vender is to be operated until temperatures on the fan motor stabilize, fuses open or burnout of the thermoelectric module occurs. The vender shall comply with 78.1.2(a), (b) and (c).

78.4 Thermoelectric circuits powered by other than an extra-low-voltage circuit

78.4.1 For a thermoelectric vender powered by other than an extra-low-voltage circuit, immediately following the tests in 78.2.1 if no fan is provided or 78.3.1 if provided with a fan, the Dielectric-Voltage Withstand Test, Section 64 shall be conducted. The potential is to be applied between the live parts of the semiconductor thermoelectric module and dead metal parts.

78.5 Dielectric-Voltage Withstand – 5000 Volt Test

78.5.1 This test applies to a thermoelectric vender in which the tests specified in 78.1.1 – 78.1.3 are not conducted.

78.5.2 Two sample thermoelectric modules shall be used for this test. One sample of the module shall be conditioned for 40 hours at 73.4 ±3.6°F (23.0 ± 2.0°C) and 50 ±5 percent relative humidity. The other sample shall be conditioned for 96 hours while being exposed to moist air having a relative humidity of 90 ±5 percent at a temperature of 95.0 ±3.6°F (35.0 ±2.0°C).

78.5.3 Immediately following the conditioning, each thermoelectric module sample, including any sealant at the lead connections, shall be wrapped with aluminum foil and a potential of 5000 volts shall be applied between the high-voltage live parts of the module and the foil.

79 Overload Test – High-Voltage Transformers

79.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 31.1.7. The transformer shall comply with the Dielectric Voltage-Withstand Test, Section 64, following the test specified in 79.3 and 79.4.

79.2 Temperatures of a thermally protected high-voltage transformer, measured on the surface of the windings, shall not exceed the insulation temperature rating when the transformer is tested as indicated in

79.3 and 79.4. Insulation temperature rating is defined as the rating for the class of insulation; such as, 105°C for Class 105 insulation, 130°C for Class 130 insulation, and the like.

79.3 A variable resistance load is to be connected to the output terminals and the transformer operated continuously at the normal test voltage indicated in Table 60.1. If the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be in the circuit. The test ambient temperature is to be approximately 25°C (77°F). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of approximately 10°C (18°F) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

79.4 Three samples of the transformer-protector combination are to be tested. Average temperatures of the three samples shall not exceed the winding insulation rating and the temperature of any one sample shall not exceed the insulation rating by more than 5°C (9°F).

80 Overvoltage and Undervoltage Tests

80.1 A relay, solenoid, or other electromagnetic component shall withstand 10 percent above rated voltage without damage to the operating coil and operate successfully at 15 percent less than normal voltage.

80.2 A relay or solenoid that has been separately investigated for the voltage and operating conditions involved, including ambient temperature conditions, is not required to be tested in the vender to determine if it complies with the requirements in 80.1.

80.3 The vender is to be connected to a supply source maintained at the overvoltage indicated in Table 60.1 and operated through 100 vending cycles at 10 second intervals or as rapidly as the design permits. The temperatures of relay coils, solenoids, and other electromagnetic components are then to be allowed to stabilize. The potential is then to be reduced to the normal test voltage indicated in Table 60.1. Each electromagnetic component is to operate at this voltage. The potential is to be maintained at the normal test voltage until coil temperatures stabilize. The potential is then to be reduced to the undervoltage condition indicated in Table 60.1. Each electromagnetic component is to operate at this voltage, except as indicated in 80.4. If the components are energized through a transformer, the voltage adjustments described are to be made on the primary side of the transformer.

80.4 A component that fails to operate at 15 percent below rated voltage may be accepted if it is determined that a risk of fire or electric shock will not result. See 76.1.4.

81 Limited Short-Circuit Test

81.1 General

81.1.1 The following components shall withstand short circuiting when protected by a branch-circuit overcurrent device of the size required by the product:

a) Motor overload protective devices which are connected in the motor circuit;

b) Motor circuit conductors and connections as required by 81.4.1;

c) Bonding conductors and connections as required by 16.1.5 and 16.1.6; and

d) Capacitor employing a liquid dielectric medium. See 21.2(c).

81.1.2 For a cord-connected unit, the protection specified in 81.1.1 is to be provided by a fuse having a rating not less than the rating of the unit's attachment plug. The minimum fuse size for cord-connected venders is 20 amperes for units rated 125 volts or less and 15 amperes for units rated 126 – 250 volts.

81.1.3 For a permanently-connected unit, the protection specified in 81.1.1 is to be provided by either:

a) A device that is recognized for branch-circuit protection and located in the unit; or

b) A branch-circuit protective device of the type and maximum rating specified on the product nameplate.

81.1.4 Except as specified in 81.1.5, a permanently-connected vender having more than one motor wired for connection to one supply line shall withstand short-circuiting when protected by a branch-circuit overcurrent device rated at 225 percent of the rated-load or maximum rated current of the largest hermetic motor of the group plus an amount equal to the sum of any additional loads supplied. If a hermetic motor is not supplied, the branch-circuit overcurrent protective device shall be rated 400 percent of the full-load or maximum operating current of the largest motor of the group plus an amount equal to the sum of any additional loads supplied.

81.1.5 If a branch-circuit overcurrent device:

a) Smaller than that specified in 81.1.4 is used, the vending machine shall start and operate without opening a fuse having the smaller rating.

b) Is incorporated within the vending machine, the test specified in 81.1.4 shall be conducted with that overcurrent device.

81.1.6 In reference to 81.1.5(a), a fuse rated less than 15 amperes shall not be used.

81.1.7 With respect to branch-circuit overcurrent protective devices and for the purpose of these tests, fuses of the same rating are considered to be interchangeable and circuit breakers of the same rating are considered to be interchangeable. Fuses and circuit breakers are not considered to be interchangeable.

81.1.8 The component is to be connected in a test circuit having a capacity based on the full-load current and voltage rating of the vender. See Table 81.1:

a) If the full-load current is between two values in the table, the larger value is to be used in determining the circuit capacity. If the vender nameplate shows individual loads, the full-load current is the total of all individual loads which may occur simultaneously. If more than one simultaneous load condition is possible, the condition resulting in the maximum total current is to be used as a basis for determining the capacity of the test circuit.

b) The voltage for the test circuit is to be an alternating current supply, and the circuit capacity is to be measured without the component in the circuit.

c) The power factor of the test circuit is to be 0.9 – 1.0 unless a lower power factor is agreeable to those concerned.

Table 81.1
Short-circuit test currents

Full-load amperes[a]				Circuit Capacity Amperes
Single phase				
115 V	208 V	230 – 240 V	277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000

Table 81.1 Continued on Next Page

Table 81.1 Continued

Full-load amperes[a]				Circuit Capacity Amperes
Single phase				
115 V	208 V	230 – 240 V	277 V	
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 44.0	–	3500
Over 80.0	Over 44.0	Over 44.0	Over 6.65	5000
Three Phase				
208 V	220 – 240 V	440 – 480 V	550 – 600 V	
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.8 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

[a] Refrigerated vender.

81.1.9 Three samples of each component or conductor under test are to be subjected to each test condition and a new protective device is to be used for each test. Consideration is to be given to both short-circuit and ground-fault conditions.

81.2 Motor Overload Protective Devices

81.2.1 There shall be no ignition of cheesecloth surrounding the enclosure of a motor protective device when samples are subjected to the test.

81.2.2 If a thermally protected motor or a separately enclosed motor overload protective device is within an outer cabinet, and if the assembly is constructed so that flame and molten metal will be confined within the cabinet and there is no flammable material except electrical insulation within the cabinet, the short-circuit test may be waived.

81.3 Bonding conductors and connections

81.3.1 Bonding conductors and connections shall not open when samples are subjected to this test.

81.4 Motor circuit conductors and connections

81.4.1 Conductors of motor circuits in having two or more thermal- or overcurrent-protected motors, wired for connection to one supply line, shall withstand the Limited Short-Circuit Test, 81.1.2 – 81.1.9.

Exception: Conductors that comply with one or more of the following are acceptable without test:

a) A conductor that has an ampacity of not less than one-third the ampacity of the branch-circuit conductors as determined in accordance with 14.2.6;

b) A conductor that is 18 AWG (0.82 mm^2) or larger and not more than 4 feet (1.2 m) in length, provided that the circuit will be protected by a fuse or a circuit breaker rated not more than 60 amperes; or

c) A conductor that serves as a jumper lead between controls, provided that either the length of lead does not exceed 3 inches (76.2 mm) or the conductor is located in a control panel.

81.4.2 Motor circuit conductors and connections shall not be damaged when samples are subjected to this test.

81A Switch Mode Power Supply Units – Overload Test

81A.1 The test applies to switch mode power supply units as specified in 43.1(c).

81A.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.

81A.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.

81A.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.

81A.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.

81A.6 If no overcurrent protection is provided, the maximum overload is the maximum power output obtainable from the power supply.

81A.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.

81A.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.

82 Protective Devices – Maximum Continuous Current Test

82.1 To determine if a thermal or a protective system complies with the requirement in 29.3.2, the vender is to be tested as specified in 82.2 unless the motor-compressor has been separately tested as described in 82.4.

82.2 Except as indicated in 82.3, the vender is to be connected to a circuit of rated voltage and operated under the conditions described in Table 82.1 for at least 1 hour or until stable conditions have been reached, whichever is longer.

a) The voltage then is to be reduced in steps of 2 percent of rated voltage (to the nearest integral volt). Operation is to be allowed to become stable after each reduction in voltage before the next reduction is made, and readings of current input to the motor-compressor are to be noted after stable operation is obtained subsequent to each voltage reduction.

b) If the vender will operate at 90 percent of rated voltage without tripping the motor protective device, the first step in voltage reduction may be to 90 percent of rated voltage followed by alternate stabilization periods and 2 percent steps in voltage reduction as outlined in (a).

c) This procedure is to be continued until the protective device opens the circuit. The motor-compressor current input at the lowest voltage step during which continuous operation occurs (the

lowest voltage preceding the voltage at which the protective device opens the circuit) is to be used as a basis for judging compliance with the requirements in 29.3.2.

82.3 With reference to 82.2, initial operation may be at the voltage at which the current input is 156 percent of the rated current. The voltage then is to be reduced by 2 percent of rated voltage (to the nearest integral volt) to determine whether the protective device opens. The voltage may be reduced to the motor-compressor only, with the other components in the vender maintained at rated voltage or higher if the results of the test under these conditions indicate compliance with 29.3.1(b). The rated voltage referred to is the highest of the rated voltages for dual-voltage-rated units. Stable operation is considered to be obtained when two consecutive readings, 15 minutes apart, of the temperature on top of the motor-compressor shell do not change more than 0.6°C (1°F).

82.4 The motor-compressor, with its protective system as employed in the vender, may be tested separately as described in 82.2 and 82.3 under the conditions described in Table 82.2. This separate test may be used as a basis for judging compliance with requirements in 29.3.2.

Table 82.1
Test conditions for calibration of thermal protectors and protective systems in the vender

Location	Temperature	
	°C	°F
Air surrounding unit	40	104
For water-cooled unit		
Water entering condenser	26.7	80
Water leaving condenser	37.8[a]	100
For air-cooled unit		
Air entering condenser	40	104

[a] Where this condition cannot be attained due to the design of the unit, the unit is to be tested at 26.7°C (80°F) inlet condenser water temperature and 35 psig (241 kPa) nominal pressure.

Table 82.2
Test conditions for calibration of thermal protectors and protective systems separately from the vender

Location	Temperature	
	°C	°F
Return Gas		
Saturated Vapor Temperature	0	32
Superheat	26.7	48
Discharge Gas		
Saturated Vapor Temperature	60	140
Ambient Air		
Temperature	50	122
Velocity	2.0 m/s	400 fpm[a]

[a] The velocity specified is the horizontal air velocity in the test chamber without the compressor installed. The actual velocity across the compressor may be different from this value, depending on the shape of the compressor and its effect on the air-flow pattern. A higher velocity may be employed if the results of the test with the higher air velocity indicate compliance with 29.3.2.

83 Strength Tests

83.1 High side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Five times the marked high side design pressure. See 101.8.

b) Five times the maximum pressure developed in the Temperature and Pressure Test, Section 63.

c) Five times the start-to-discharge pressure of a pressure relief valve or five times the set pressure of a rupture member.

d) For a unit containing more than 22 pounds-mass (10 kg) of refrigerant, three times the maximum adjustable setting of the pressure limiting device.

e) For a unit equipped with a fusible plug, 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

f) For an air cooled unit, three times the maximum high side pressure developed in the Fan Motor Failure Test, Section 69.

g) For water cooled units, five times the pressure developed in the water failure test, Section 71.

h) One and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

83.2 The components as specified below and having a working pressure not less than required by 83.1 or 83.4, as applicable, are acceptable without test:

a) Pressure vessels bearing the ASME Code "U" symbol; or

b) Refrigerant-containing components complying with UL 207

83.3 A refrigerant containing component having a marked working pressure shall have an ultimate strength equal to five times the marked pressure.

83.4 Low side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Three times the marked low side design pressure. See 101.8.

b) Three times the maximum low side pressure developed in the Temperature and Pressure Test, Section 63, including equalization pressure developed after compressor shutdown.

c) For an air cooled unit, three times the maximum low side pressure developed in the Condenser Fan Motor Failure Test, Section 69, including discharge pressure relieved to the low side and equalization pressure developed after compressor shutdown.

d) For a water cooled unit, three times the maximum low side pressure developed in the Water Failure Test, Section 71, including discharge pressure relieved to the low side and equalization pressure developed after compressor shutdown.

e) One and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

Exception No. 1: Low side pressure vessels shall have an ultimate strength of not less than five times the highest of the following:

a) Low side design pressure;

b) Maximum pressure developed during the Temperature and Pressure Test, Section 63;

c) Start-to-discharge pressure of a pressure relief valve; or

d) The set pressure of a rupture member.

Exception No. 2: Low side pressure vessels protected by a fusible plug shall have an ultimate strength not less than 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

83.5 With reference to 83.1(i) and 83.4(e), vapor pressures of R12, R22, R134a, R500 and R502 at 60°C (140°F) are 207, 337, 229, 248, and 362 psig (1427, 2323, 1579, 1720, and 2496 kPa), respectively.

83.6 Sections of the refrigerant system constructed of continuous tubing or of lengths of tubing connected by hard-soldered, brazed, or welded joints will be considered as meeting the requirements of 83.1 – 83.4, provided the tubing employed in the assembly conforms with 57.2.1.

83.7 Except as specified in 57.1.4 and 57.1.5, the requirements in Strength Tests, Section 83 shall be applied to venders in which the marked high-side design pressure equals or exceeds the critical pressure of the refrigerant.

83.8 Two samples of each refrigerant containing part are to be tested to determine compliance with the requirements for strength. The test medium is to be any nonhazardous liquid such as water. The test samples are to be filled with the test medium to exclude air and are to be connected in a hydraulic pump system. The pressure is to be raised gradually until the required maximum is reached. This pressure is to be maintained for 1 minute, during which time the sample shall not burst or leak. Leakage is to be determined visually; for example, by examination of the sample for release of the test medium or by evidence of decreasing gauge pressure.

Exception: Leakage at gaskets is acceptable in components of venders containing Refrigerant 12, Refrigerant 22, or Refrigerant 134a, if the leakage occurs at a pressure greater than 40 percent of the required pressure.

83.9 Pressure actuated refrigeration controllers rated for the application are exempt from the strength test requirements.

83.10 Except as specified in 83.11, parts of a carbonation system pressurized by compressed gas or a pump, shall withstand, without failure, a pressure equal to the higher of:

a) Five times the start-to-discharge pressure of the relief valve;

b) Five times the maximum pressure that the pump can develop, if parts are pressurized by a pump; or

c) Not less than 650 psig (4.5 MPa).

83.11 With reference to 83.10, if leakage occurs, it shall only occur at valves, tubing, and connections. Tests on three samples of each leaking part shall demonstrate that:

a) Leakage occurs at a pressure greater than 40 percent of the pressure required by 83.10; and

b) Liquid from such leakage does not impinge on uninsulated live parts.

83.12 With reference to 83.10, carbonation system parts include pump housings, containers, interconnecting lines, and fittings which form part of a closed pressurized system.

83.13 The carbonation system parts shall be tested as described in 83.8.

84 Glass Strength Test

84.1 Impact test

84.1.1 One sample of exterior glass as specified in 13.1.5 shall be subjected to the test described in 84.1.2. 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.

84.1.2 The sample is to be subjected to a 2-1/2 ft-lbf (3.4 J) impact by means of 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.

84.2 Mechanical pressure test

84.2.1 One sample of exterior glass as specified in 13.1.6 shall be subjected to the test described in 84.2.2. As a result of the test, the sample shall withstand the specified force and shall not break and the supporting means shall not be damaged to the extent that it does not support the glass.

84.2.2 The sample shall withstand a gradually applied force of 50 lbf (223 N) for one minute. The force is to be evenly distributed and applied through a 3-in (76-mm) diameter resilient disc located in the center of the glass area.

Exception No. 1: If the entire section of glass is located at a distance greater than 3.5 ft (1.1 m) and less than 6 ft (1.8 m) above floor level and is in a plane that is 45 degrees or less with the vertical plane, the applied force is to be 35 lbf (156 N).

Exception No. 2: If the entire section of glass is located 6 ft (1.8 m) or greater above floor level, this test does not apply.

85 Glass Component Strength Test

85.1 Three samples of a glass component as described in 13.1.9 shall be subjected to the test specified in 85.2. As a result of the test, the samples shall withstand the specified impact without breaking.

85.2 Each sample is to be subjected to a 1.6 ft-lbf (2.2 J) impact by means of 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 component.

Exception: Using a panel of flat glass of the type used in a vendor complies when it is determined that the results of the test on the separate panel is representative of the component as used in the vendor.

86 Strain Relief Test

86.1 When a vender is tested in accordance with 86.2 – 86.5, there shall be no movement of the cord or wiring leads to indicate that stress is transmitted to internal connections and wiring.

86.2 A strain relief means for a power supply cord, including that for an externally-mounted accessory is to 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 vender.

86.3 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 vender leads.

86.4 The force specified in 86.2 or 86.3 shall be applied so that the strain relief is stressed from any angle permitted by the construction of the vender.

86.5 The force shall be applied for not less than 1 minute.

87 Push-Back Strain-Relief Test

87.1 To determine compliance with 15.15, a vender shall be tested in accordance with 87.2 without occurrence of any of the conditions specified in 15.15(a) – (d).

87.2 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 vendor and is then to be pushed back into the vendor. The cord is to be pushed back into the vendor in 1 in (25.4 mm) increments until the cord buckles or the force to push the cord into the vendor is greater than 6 lbf (26.7 N). The cord within the vendor 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.

88 Wiring Endurance Test

88.1 A vender tested in accordance with 88.2 – 88.4, shall have no broken conductors, individual strands shall not penetrate the insulation and there shall be no damage to the wiring.

88.2 Wiring subject to movement shall be tested by cycling the moving part(s) through the maximum travel permitted by the design. If the electrical component to which the wiring is connected is exposed to the user, the duration of the endurance test shall be 100,000 cycles, otherwise the test shall be for 6,000 cycles.

88.3 Restraints, such as chains, clamps, and the like, that may be provided on the vender shall remain in place during the test.

88.4 Following the endurance cycling, the vender shall be subjected to the Dielectric Voltage Withstand Test, Section 64, and the wiring examined for damage. No dielectric breakdown shall occur.

89 Accelerated Aging Tests on Gaskets and Adhesives

89.1 The requirements in 89.2 – 89.6 apply to gaskets required as seals for electrical enclosures of venders intended for outdoor use. The requirements in 89.7 applies to adhesives required to secure such gaskets to enclosures or covers.

89.2 Tensile strength and elongation are to be determined using the test methods and apparatus described in ASTM D412.

89.3 Neoprene or rubber compounds, except foamed materials, forming gaskets shall have physical properties before and after an air oven aging for 70 hours at 100 ±2°C (212 ±3.6°F), as indicated in Table 89.1.

Table 89.1
Physical properties for gaskets

	Before test	After test
Recovery – Maximum set when 1 inch (25.4 mm) gauge marks are stretched to 2-1/2 inches (63.5 mm), held for 2 minutes, and measured 2 minutes after release	1/4 inch (6.4 mm)	–
Elongation – Minimum increase in distance	250 percent (1 to 3-1/2 inches) (25.4 – 88.9 mm)	65 percent of original
Tensile strength – minimum force at breaking point	850 psi (5.86 MPa)	75 percent of original

89.4 Foamed neoprene or rubber compounds forming gaskets are to be subjected to an air oven aging for 70 hours at 100 ±2° C (212 ±3.6° F). The compounds shall not harden or otherwise deteriorate to a degree which will affect their sealing properties.

89.5 Thermoplastic materials forming gaskets are to be subjected to a test involving exposure in an air oven at 87° C (188.6° F) for a period of 7 days. The material shall not deform or melt, or otherwise deteriorate to a degree which will affect its sealing properties.

89.6 With reference to 89.5, polyvinyl chloride gasket material shall have an ultimate tensile strength of not less than 1200 psi (8.27 MPa) and an ultimate elongation of not less than 250 percent before the air-oven test. The minimum tensile strength is to be not less than 90 percent and the elongation not less than 75 percent of the original values after the air-oven test.

89.7 The force required to peel a gasket that is secured by adhesives from its mounting surface after exposure shall not be less than 75 percent of the value determined on "as-received" samples. Samples of the adhesive and mounting surface are to be exposed for a period of 72 hours to each of the following conditions:

a) 100°C (212°F);

b) 32°C (89.6°F) and 87 percent relative humidity; and

c) minus 10°C (14°F).

90 Metallic Coating Thickness Test

90.1 The solution to be used for the metallic coating thickness tests required in 13.2.4 and 13.2.5 is to be made from distilled water and is to contain 200 grams per liter of chemically pure chromic acid, CrO_3; and 50 grams per liter of chemically pure concentrated sulphuric acid, $H_2 SO_4$. (The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulphuric acid, specific gravity 1.84, containing 96 percent of $H_2 SO_4$.)

90.2 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 of approximately 0.025 inches (0.64 mm) inside bore and 5.5 inches (140 mm) long. The lower end of the capillary tube is 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 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 desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

90.3 The sample and the test solution should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature of 21 – 32°C (70 – 90°F).

90.4 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of suitable 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 materials.

90.5 The sample to be tested is to be supported 0.7 – 1 inch (17.8 – 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 about 45 degrees from horizontal.

90.6 After cleaning, the sample to be tested is to be put in place under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stop watch until the dropping solution dissolves off the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by the change in color at that point.

90.7 Each sample of a test lot is to be tested 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 metallic 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.

90.8 To calculate the thickness of the coating being tested, select from Table 90.1 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 90.6.

Table 90.1
Coating thickness factors

Thickness Factors, 0.00001 inches (0.0003 mm) per second			
Temperature		Cadmium platings	Zinc platings
°C	(°F)		
21.1	(70)	1.331	0.980
21.7	(71)	1.340	0.990
22.2	(72)	1.352	1.000
22.8	(73)	1.362	1.010
23.3	(74)	1.372	1.015
23.9	(75)	1.383	1.025
24.4	(76)	1.395	1.033
25.0	(77)	1.405	1.042
25.6	(78)	1.416	1.050
26.1	(79)	1.427	1.060
26.7	(80)	1.438	1.070
27.2	(81)	1.450	1.080
27.8	(82)	1.460	1.085
28.3	(83)	1.470	1.095
28.9	(84)	1.480	1.100
29.4	(85)	1.490	1.110
30.0	(86)	1.501	1.120
30.6	(87)	1.513	1.130
31.1	(88)	1.524	1.141
31.7	(89)	1.534	1.150
32.2	(90)	1.546	1.160

91 Label Adhesion Tests

91.1 General

91.1.1 With reference to 101.2, after being subjected to the conditions described in 91.2.1 – 91.5.1, a pressure-sensitive label or a label secured by cement or adhesive is considered to be of a permanent nature if; immediately following removal from each test medium; and after being exposed to room temperature for 24 hours following removal from each medium:

a) The edges of each sample are not curled.

b) The label cannot be defaced or be removed as demonstrated by scraping across the test panel with a flat metal blade 1/16 inch (1.6 mm) thick, held at a right angle, to the test panel.

c) The printing is legible and is not defaced by rubbing with thumb or finger pressure.

Exception: This test does not apply to a pressure-sensitive label or a label secured by cement or adhesive that complies with UL 969.

91.2 Oven-aging test

91.2.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in an air oven maintained at the temperature indicated in Table 91.1 for 240 hours.

Table 91.1
Oven-aging test temperatures

Maximum temperature of surface to which applied[a]		Test temperature	
°C	°F or less	°C	°F
60	(140	87	(189)
80	(176)	105	(221)
100	(212)	121	(250)
125	(257)	150	(302)
150	(302)	180	(356)
Over 150°C (302°F)		[b]	

[a] As measured during temperature tests.

[b] A label which is applied to a surface attaining a temperature greater than 150°C (302°F) during the temperature tests is to be oven-aged at a temperature which is representative of the temperatures attained by the vender during normal and abnormal operation.

91.3 Immersion test

91.3.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 23 ±2°C (73.4 ±3.6°F) with a 50 ±5 percent relative humidity for 24 hours. The samples are then immersed in water at a temperature of 21 ±2°C (69.8 ±3.6°F) for 48 hours.

91.4 Standard atmosphere test

91.4.1 Three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 23 ±2°C (73.4 ±3.6°F) with 50 ±5 percent relative humidity for 72 hours.

91.5 Unusual condition exposure test

91.5.1 If the labels are exposed to unusual conditions in service, such as oil, grease, cleaning solutions, soft drink syrup, or the like, three samples of the label applied to test surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 23 ±2°C (73.4 ±3.6°F) with a 50 ±5 percent relative humidity for 24 hours. The samples are then immersed for 48 hours in a solution representative of service use maintained at the temperature the solution would attain in service, but in no case less than 23 ±2°C.

92 Tests on Nonmetallic Materials

92.1 Nonmetallic materials are to be evaluated as specified in Table 92.1.

Table 92.1
Tests on nonmetallic materials-based on nonmetallic requirements in Sections 7 – 10

Nonmetallic Component	Applicable Test Number
A part serving as an enclosure for ignition sources	1[a], 2[a], 3[b] or 4[h], 6, 7[c], 8[d], 9, 10, 11, 12, 13, 14, 15
A part serving as a cabinet	Minimum 4[h], 6, 7[c], 8[d], 9, 10, 11, 12, 13, 14, 15
A functional part	Minimum 4[h], 6, 7[c], 8[d], 10, 11, 12, 13
A nonfunctional part	Minimum 4[h], 9

NOTES

1. 5 inch end product flame test[e].

2. 5V rated material[f].

3. V-0, V-1, V-2, HF-1, HF-2 rated materials[f], 3/4 inch End Product Flame Test[e] or 12 mm End Product Flame Test[e].

4. HB or HBF rated material[f] or a material with a flame spread rating of 25 or less and a smoke developed rating of 50 or less[g].

5. HBF, HF-1, HF-2 rated materials[f].

6. Mold Stress-Relief Test[e].

7. Fastener Strength Test, Section 93.

8. Adhesive Test[e].

9. Radiant Panel or Surface Burning Characteristic Test[g]. A flame spread index (FSI) of not more than 200 applies only to parts forming portions of the external enclosure, or of a decorative part if the total area of the enclosure exceeds 10 ft.^{2} (0.93 m^2).

10. Volume Resistivity Test[e] – Applies only if electrical spacings between uninsulated live parts and the material are less than specified in high-voltage circuits, and low voltage circuits, or if the part is used as indirect support of an uninsulated live part.

11. High Current Arc Ignition Test[e] – Applies only if the material is used to enclose uninsulated live parts or to provide indirect support of uninsulated live parts. The test does not apply if uninsulated live parts are located a minimum of 1/32 inch (0.79 mm) from the part. If applicable, no ignition shall occur to: V-0 materials subjected to 15 arcs; V-1, V-2, or 5V materials subjected to 30 arcs, or to HB materials subjected to 60 arcs.

12. Hot Wire Ignition Test[e] – Applies only if the material is within 1/2 inch (12.7 mm) of electrically-heated wires or resistors. If applicable, ignition shall not occur in less than: 10 s for V-0 materials, 15 s for V-1 or 5V materials, or 30 s for V-2 or HB materials.

13. Impact Tests[e] – 5 ft-lb (6.8 J) impact for enclosures containing uninsulated live and hot parts, 1.5 ft-lb (2.0 J) impact for enclosures containing moving parts.

14. Crush Resistance Test[e] – Only one sample needs to be tested.

15. UV Light Exposure Test[e] – Applies to venders intended for outdoor or protected locations and provided with a polymeric cabinet and/or enclosure that could be exposed to sunlight.

[a] An enclosure provided with a barrier interposed between the material and an ignition source will be tested with the barrier in place.

[b] A material with a V-2 minimum rating is able to be used to enclose an ignition source if the ignition source is only energized as a result of a continuous action by an attending operator.

[c] Applies to an enclosure that serves only to reduce the risk of electric shock and having ultrasonic welds; heat welds; polymeric screws or nuts; metal screws threaded into a polymeric part, or other means where degradation of a polymeric material affects securement.

[d] Applies only if the adhesive is relied on to maintain the integrity of an enclosure or functional part.

[e] Tested or rated as described in UL 746C.

[f] Tested or rated as described in UL 94.

[g] Tested or rated as described in ASTM E162 or UL 723.

[h] These materials are able to be used if ignition sources are separated or isolated in accordance with Nonmetallic Material Ignition Sources Separation, Section 9.

93 Fastener Strength Test

93.1 With reference to the requirement in 10.2, nonmetallic fasteners that can degrade and affect the integrity of an enclosure shall comply with 93.2 and 93.3.

93.2 The tightening torque and pull-off strength of such fasteners shall be not less than 50 percent of the as-received value.

93.3 Three sets of samples, each set consisting of three specimens, shall be temperature conditioned as specified in Table 93.1 and Table 93.2.

Table 93.1
Test specifications

Sample Set	Number of Samples	Test Specifications
1	3	As-received (no conditioning).
2	3	Oven aging – 300 hours at the service temperature plus 18°F (10°C) but not less than 158°F (70°F). Service temperature is considered to be the temperature measured during the Temperature and Pressure Tests, Section 63; and Heating Test, Section 65.
3	3	Heat cycling – 40 cycles of alternate heating and cooling at the temperatures specified in Table 93.2. Each cycle is to consist of 4 hours at the upper temperature followed by 4 hours at the lower temperature.

Table 93.2
Temperature cycling parameters

Location	Upper Temperature	Lower Temperature
Nonrefrigerated Areas	Service temperature plus 18°F (10°C) but not less than 158°F (70°C)	77°F (25°C)
Refrigerated Areas	90°F (32°C)	32°F (0°C)
Low Temperature Area	90°F (32°C)	0°F (minus 17.8°C)

94 Refrigerant Identification Tests

94.1 General

94.1.1 These tests are applicable to refrigerants required to be subjected to a compositional analysis in accordance with 56.2 (b) and 56.3. The infrared analysis in 94.2 applies to single component ("pure") refrigerants. The Gas Chromatography Analysis, Section 94.3 applies to blended (more than one component) refrigerants.

94.2 Infrared analysis

94.2.1 An infrared analysis shall be performed with a Fourier Transform Infrared (FTIR) spectrometer and/or Dispersive Infrared spectrophotometer. The infrared spectra obtained shall consist of a minimum wavenumber range of 4000 – 400 reciprocal centimeters.

94.2.2 A representative sample of a single component refrigerant shall be captured in a sealed cell and the infrared spectra of the refrigerant shall be obtained.

94.2.3 The results shall be recorded as a plot of the percent transmittance of the infrared radiation through the specimen versus the reciprocal wavelength (cm-1) or "wavenumber" of the radiation. Percent transmittance shall be expressed on the ordinate and "wavenumber" on the abscissa.

94.3 Gas chromatography analysis

94.3.1 A gas chromatography analysis shall be performed with a gas chromatograph using thermal conductivity, flame ionization or equivalent detection.

94.3.2 A representative aliquot of liquid of the blended refrigerant shall be transferred to an evacuated container and allowed to vaporize. A known volume of the vaporized sample shall be injected into a gas chromatograph that has been calibrated for the sample component(s). A chromatogram of the refrigerant shall be obtained.

94.3.3 The results shall be recorded as a plot of time, measured from the start of the analysis on the abscissa, versus the detector response of the individual fractions of the refrigerant on the ordinate.

95 Protective Electronic Circuit Tests

95.1 General

95.1.1 The tests in 95.2 – 95.5 are applicable to vending machines provided with a protective electronic circuit and intended to comply with 29.5.1(c) or 30.1.14(h).

95.1.2 User adjustable controls shall be adjusted to their most unfavorable setting.

95.2 Fault conditions abnormal test

95.2.1 Following the application of the operational fault conditions in accordance with 95.2.2 – 95.2.5, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The vending machine shall comply with the Dielectric Voltage Withstand Test, Section 64.

95.2.2 In accordance with 30.1.29(b), an appliance provided with a protective electronic circuit intended to comply with 29.5.1(c) or 30.1.14(h) shall be operated as specified in the Temperature and Pressure Test, Section 63 except the room ambient shall be maintained at 21.1 – 26.7ºC (70 – 80ºF). The appliance protective electronic circuit shall then be subjected to any one of the following relevant operational fault conditions, each consecutively applied one at a time:

a) Open circuit at the terminals of any component;

b) Short circuit of capacitors, unless they comply with UL 60384-14;

c) Short circuit of any two terminals of an electronic component, including a metal oxide varistor (MOV). For the test applicable to an integrated circuit, see item (e);

d) Failure of triacs in the diode mode;

e) Failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals occurring within the component which may result in the appliance not complying with 95.2.1 shall be considered;

f) Failure of an electronic power switching device, such as a field effect transistor and a bipolar transistor (including the insulated gate type) in a partial turn-on mode with loss of gate (base) control;

g) Short-circuiting of any circuit that differs in voltage from the supply source of the protective electronic circuit by connecting the different voltage circuit to the supply source.

95.2.3 In reference to 95.2.2, the following items shall be considered:

a) If the fault specified in 95.2.2(c) is not applied:

i) Between two circuits of an optical isolator, then the optical isolator shall comply with UL 1577.

ii) To the short circuiting of an electronic surge protective device, such as a metal oxide varistor (MOV), then the MOV shall comply with the Type 4 requirements in UL 1449.

b) For evaluating encapsulated or similar components, if the circuit and/or components cannot be evaluated by other methods, then 95.2.2(e) shall be applied.

c) For evaluating the components in 95.2.2(f), one method for simulating this mode is to disconnect the electronic power switching device gate (base) terminal and then connect an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply can then be varied to obtain the current which is the most severe but which does not damage the electronic power switching device.

d) Step-function positive temperature coefficient thermistors (PTC-S) shall be short-circuited unless they comply with the DC PTC Thermistors requirements in 14.5.3 of UL 60065.

e) If more than one of the operational fault conditions in 95.2.2 (a) – (g) are applicable to the appliance, the appliance shall be allowed to cool down to room temperature after the application of each fault condition unless such cooling is determined not to adversely impact the test results.

95.2.4 The operational fault conditions specified in 95.2.2 (a) – (g) shall be considered completed if a manual reset (non-self-resetting) device opens the supply circuit. If the supply circuit is not opened by such a device, then the fault conditions shall be applied until thermal equilibrium is established.

95.2.5 An appliance provided with a protective electronic circuit intended to comply with 29.5.1 (c) or 30.1.15 (h) shall additionally be operated as specified 95.2.2 except that the appliance shall first be subjected to the relevant abnormal condition(s) addressed by Sections 13.3, 13.4, 28, 29, 58, 69, 71, 76 – 78. The appliance protective electronic circuit shall then be subjected to any one of the relevant operational fault conditions as outlined in 95.2.2 (a) – (g), each consecutively applied one at a time.

95.3 Electromagnetic compatibility (EMC) tests

95.3.1 In accordance with 30.1.29 (e), an appliance having a protective electronic circuit intended to comply with 29.5.1 (c) or 30.1.14 (h) shall be subjected to the electromagnetic phenomena specified in 95.3.3 – 95.3.9, each applied one at a time. Each test shall be carried out:

a) After a protective electronic circuit has operated during the relevant abnormal condition (s) specified by Sections 13.3, 13.4, 28, 29, 58, 69, 71, 76 – 78 taking into account the most severe results (e.g., highest temperatures, pressures, etc.);

b) At conditions specified in the Temperature and Pressure Test, Section 63 except that the room ambient shall be maintained at 21.1 – 26.7ºC (70 – 80ºF) unless different conditions are required by the specific abnormal condition being applied; and

c) With surge protective devices disconnected unless they incorporate spark gaps.

95.3.2 Following the application of each electromagnetic stress, a protective electronic circuit shall continue to operate as intended. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The vending machine shall comply with the Dielectric Voltage Withstand Test, Section 64.

95.3.3 Electrostatic discharges shall be applied in accordance with IEC 61000-4-2, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity shall be applied at each preselected point.

95.3.4 Radiated fields shall be applied in accordance with IEC 61000-4-3. The frequency ranges tested shall be 80 MHz to 1000 MHz, test level 3; 1.4 GHz to 2.0 GHz, test level 3; and 2.0 GHz to 2.7 GHz, test level 2. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

95.3.5 Fast transient bursts shall be applied in accordance with IEC 61000-4-4. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity.

95.3.6 Voltage surges shall be applied to the appliance power supply terminals in accordance with IEC 61000-4-5, with five positive impulses and five negative impulses being applied at the selected points. An open circuit test voltage of 2 kV is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 ohms being used. An open circuit test voltage of 4 kV is applicable for the line-to-ground coupling mode, a generator having a source impedance of 12 ohms being used. Sheathed heating elements in which a metal sheath is bonded in accordance with 16.1.1 shall be electrically disconnected during this test. For appliances having surge arresters incorporating spark gaps, the test shall be repeated at a level that is 95 percent of the flashover voltage. If a feedback system depends on inputs related to a disconnected heating element, an artificial network may be needed.

95.3.7 Injected currents shall be applied in accordance with IEC 61000-4-6, test level 3 being applicable. During the test, all frequencies between 0.15 MHz to 80 MHz shall be covered. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

95.3.8 Voltage dips and interruptions specified as test level Class 3 shall be applied in accordance with:

a) IEC 61000-4-11, for vending machines having a rated current not exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-11 shall be applied at zero crossing of the supply voltage; or

b) IEC 61000-4-34, for vending machines having a rated current exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-34 shall be applied at zero crossing of the supply voltage.

95.3.9 Supply source (mains) signals shall be tested in accordance with IEC 61000-4-13. Table 11 with test level Class 2 using the frequency steps according to Table 10 of IEC 61000-4-13 shall be applied.

95.4 Programmable component reduced supply voltage test

95.4.1 In accordance with 30.1.29 (f), the following test is applicable to an appliance provided with a protective electronic circuit intended to comply with 29.5.1 (c) or 30.1.14 (h) and having a programmable component for one or more of its safety functions.

95.4.2 Following the voltage changes specified in 95.4.3, an appliance shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart the appliance. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage Withstand Test, Section 64.

95.4.3 The appliance shall be operated at rated voltage and at conditions specified in the Temperature and Pressure Test, Section 63, except that the room ambient shall be maintained at 21.1 – 26.7°C (70 – 80°F) until thermal equilibrium occurs. The power supply voltage shall then be changed, by approximately 10 V/s until the voltage reductions or increases specified in (a) – (d) are attained. The power supply voltage shall then be maintained at each voltage condition for not less than 60 s as follows:

a) Voltage shall be reduced until the appliance ceases to respond to user inputs or parts controlled by the programmable component cease to operate, whichever occurs first. This value of supply voltage shall be recorded.

b) Voltage shall be increased to rated voltage so that the appliance operates as intended.

c) Voltage shall be reduced to a value that is approximately 10 percent less than the recorded voltage.

d) Voltage shall be increased so that the appliance operates as intended.

95.5 Fuse-link test

95.5.1 In accordance with 30.1.29(c), the following test is applicable to a vending machine provided with a protective electronic circuit intended to comply with 29.5.1(c) or 30.1.14(h) and in which a miniature fuse-link opens during the application of one or more of the operational fault conditions specified in 95.2.

95.5.2 The fault condition in which the miniature fuse-link opened shall be repeated in accordance with the relevant parts of Fault Conditions Abnormal Test, Section 95.2 exept with the fuse replaced by an ammeter. The current in the circuit shall be measured.

95.5.3 The resistance of the fuse-link shall be measured so that the rated current through the fuse can be determined. The current measured by the ammeter described by 95.5.2 is to be multiplied by the ammeter internal resistance and then divided by the resistance of the fuse link to obtain the rated current of the fuse-link for making the determinations specified in 95.5.4.

95.5.4 If the calculation determined in accordance with 95.5.3:

a) Is at least 2.75 times the rated current of the fuse-link, the circuit is considered to be protected and the results obtained during the tests of the Fault Conditions Abnormal Test, Section 95.2 with the fuse-link in the circuit can be used to determine compliance with 95.2.1.

b) Is between 2.1 times and 2.75 times the rated current of the fuse-link, the relevant fault condition(s) in accordance with the Fault Conditions Abnormal Test, Section 95.2 shall be repeated with the fuse-link short-circuited. The test shall be conducted until the lesser of one of the following occurs and the results shall comply with 95.2.1:

1) 2 minutes for time lag fuse-links; or

2) 30 minutes for quick acting fuse-links; or

3) until thermal equilibrium is achieved.

c) Is 2.1 times the rated current of the fuse-link or less, the circuit shall not be considered to be protected and the relevant fault condition(s) in accordance with Fault Conditions Abnormal Test, Section 95.2 shall be repeated with the fuse-link short-circuited. The results shall comply with 95.2.1.

MANUFACTURING AND PRODUCTION TESTS

96 Pressure Tests

96.1 Each vender shall be tested and proved tight at pressures not less than those design pressure(s) marked on the vender. See 101.8.