



# UL 751

## STANDARD FOR SAFETY

## Vending Machines

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UL Standard for Safety for Vending Machines, UL 751

Ninth Edition, Dated July 18, 2016

### ***Summary Of Topics***

***The revisions dated August 4, 2016 were issued to incorporate editorial changes including updating incorrect references.***

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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1

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## Standard for Vending Machines

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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 <http://csds.ul.com>.

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## CONTENTS

### INTRODUCTION

|                              |   |
|------------------------------|---|
| 1 Scope .....                | 7 |
| 2 Units of Measurement ..... | 7 |
| 3 Undated References .....   | 7 |
| 4 Terminology .....          | 7 |
| 5 Glossary .....             | 8 |

### CONSTRUCTION

|                                                                        |    |
|------------------------------------------------------------------------|----|
| 6 General .....                                                        | 11 |
| 7 Nonmetallic Parts .....                                              | 12 |
| 8 Nonmetallic Materials .....                                          | 12 |
| 9 Nonmetallic Material Ignition Sources Separation .....               | 12 |
| 10 Nonmetallic Material Application and Location .....                 | 14 |
| 11 Barriers .....                                                      | 14 |
| 12 Frame and Enclosure .....                                           | 14 |
| 13 Mechanical Assembly .....                                           | 19 |
| 14 Accessibility of Live Parts .....                                   | 20 |
| 15 Protection Against Corrosion .....                                  | 23 |
| 16 Supply Connections For Cord Connected Vending Machines .....        | 25 |
| 16.1 Cords and plugs .....                                             | 25 |
| 16.2 Strain relief .....                                               | 27 |
| 17 Supply Connections for Permanently Connected Vending Machines ..... | 27 |
| 17.1 General .....                                                     | 27 |
| 17.2 Field-wiring compartments .....                                   | 27 |
| 17.3 Field-wiring terminals and leads .....                            | 28 |
| 17.4 Equipment grounding .....                                         | 30 |
| 18 Current-Carrying Parts .....                                        | 30 |
| 19 Insulating Material .....                                           | 31 |
| 19.1 Electrical insulation .....                                       | 31 |
| 19.2 Thermal insulation .....                                          | 32 |
| 20 Internal Wiring .....                                               | 32 |
| 20.1 General .....                                                     | 32 |
| 20.2 Wires .....                                                       | 33 |
| 20.3 Routing .....                                                     | 35 |
| 21 Splices and Connections .....                                       | 35 |
| 22 Separation of Circuits .....                                        | 36 |
| 23 Heating Elements .....                                              | 36 |
| 24 Motors .....                                                        | 37 |
| 24.1 General .....                                                     | 37 |
| 24.2 Overload protection .....                                         | 37 |
| 24.3 Protective electronic circuits .....                              | 38 |
| 25 Overcurrent Protection .....                                        | 39 |
| 25.1 General .....                                                     | 39 |
| 25.2 Motors and power transformers .....                               | 41 |
| 26 Switches and Controllers .....                                      | 41 |
| 27 Remotely Operated Vending Machines .....                            | 46 |
| 28 Capacitors .....                                                    | 47 |
| 29 Receptacles .....                                                   | 48 |

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|                                                                   |    |
|-------------------------------------------------------------------|----|
| 30 Batteries and Battery Chargers .....                           | 48 |
| 31 Connectors .....                                               | 49 |
| 32 Cooking Equipment .....                                        | 49 |
| 33 Electrical Cable, Conduit and Tubing .....                     | 49 |
| 34 Electromagnetic Interference Filters .....                     | 49 |
| 35 Fuseholders .....                                              | 50 |
| 36 Lighting Systems .....                                         | 50 |
| 36.1 General .....                                                | 50 |
| 36.2 Electric-discharge lighting systems .....                    | 51 |
| 37 Optical Isolators and Semiconductor Devices .....              | 52 |
| 38 Outlet Boxes, Fittings and Cover Plates .....                  | 52 |
| 39 Power Supplies .....                                           | 53 |
| 40 Solar Photovoltaic (PV) Systems .....                          | 53 |
| 41 Information Technology Equipment .....                         | 54 |
| 42 Terminal Blocks .....                                          | 54 |
| 43 Transformers .....                                             | 55 |
| 44 Wireways, Auxiliary Gutters and Associated Fittings .....      | 55 |
| 45 Secondary Circuits .....                                       | 55 |
| 46 Spacings .....                                                 | 56 |
| 46.1 High-voltage circuits .....                                  | 56 |
| 46.2 Low-voltage circuits .....                                   | 58 |
| 46.3 Alternate spacings – clearances and creepage distances ..... | 58 |
| 47 Grounding .....                                                | 59 |
| 48 Accessories .....                                              | 62 |
| 49 Coin and Credit Mechanisms .....                               | 62 |

## PROTECTION AGAINST INJURY TO PERSONS

|                                                         |    |
|---------------------------------------------------------|----|
| 50 General .....                                        | 63 |
| 50.1 General .....                                      | 63 |
| 50.2 Switches and controllers .....                     | 64 |
| 50.3 Lids .....                                         | 64 |
| 51 Stability Test .....                                 | 64 |
| 52 Risk of Injury to Servicemen .....                   | 65 |
| 53 Pressure Vessels and Parts Subject to Pressure ..... | 65 |
| 54 Pressure-Relief Devices .....                        | 67 |

## PERFORMANCE

|                                            |    |
|--------------------------------------------|----|
| 55 General .....                           | 68 |
| 56 Leakage Current Test .....              | 68 |
| 57 Input Test .....                        | 72 |
| 58 Temperature Test .....                  | 72 |
| 58.1 General .....                         | 72 |
| 58.2 Maximum normal load .....             | 75 |
| 59 Dielectric Voltage-Withstand Test ..... | 76 |
| 60 Abnormal Operation Test .....           | 77 |
| 61 Resistance to Moisture Tests .....      | 77 |
| 61.1 Humidity .....                        | 77 |
| 61.2 Water spray .....                     | 78 |
| 62 Thermostat Tests .....                  | 81 |
| 63 Bonding Connection Test .....           | 82 |
| 64 Metallic Coating Thickness Test .....   | 82 |

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|      |                                                          |    |
|------|----------------------------------------------------------|----|
| 65   | Overload of Motor Switches or Controllers Test .....     | 83 |
| 66   | Overload and Endurance Test – Switching Devices .....    | 84 |
| 67   | Flexing of Internal Wiring .....                         | 85 |
| 68   | Strain Relief Test .....                                 | 85 |
| 69   | Push-Back Strain-Relief Test .....                       | 86 |
| 70   | Glass Strength Test .....                                | 86 |
| 70.1 | Impact test .....                                        | 86 |
| 70.2 | Mechanical pressure test .....                           | 87 |
| 71   | Glass Component Strength Test .....                      | 87 |
| 72   | Accelerated Aging Test of Gaskets .....                  | 87 |
| 73   | Permanence of Marking Test .....                         | 88 |
| 73.1 | General .....                                            | 88 |
| 73.2 | Oven-aging test .....                                    | 89 |
| 73.3 | Immersion test .....                                     | 89 |
| 73.4 | Standard-atmosphere test .....                           | 89 |
| 74   | Tests on Nonmetallic Materials .....                     | 89 |
| 75   | Fastener Strength Test .....                             | 91 |
| 76   | Protective Electronic Circuit Tests .....                | 92 |
| 76.1 | General .....                                            | 92 |
| 76.2 | Fault conditions abnormal test .....                     | 92 |
| 76.3 | Electromagnetic compatibility (EMC) tests .....          | 94 |
| 76.4 | Programmable component reduced supply voltage test ..... | 95 |
| 76.5 | Fuse-link test .....                                     | 96 |

## MANUFACTURING AND PRODUCTION TESTS

|    |                                          |    |
|----|------------------------------------------|----|
| 77 | Dielectric Voltage-Withstand Test .....  | 97 |
| 78 | Grounding Continuity Test .....          | 99 |
| 79 | Protective Electronic Circuit Test ..... | 99 |

## MARKING

|      |                                 |     |
|------|---------------------------------|-----|
| 80   | General .....                   | 100 |
| 80.1 | Permanence .....                | 100 |
| 80.2 | Identification .....            | 100 |
| 80.3 | Installation instructions ..... | 102 |
| 80.4 | Accessories .....               | 103 |
| 80.5 | Temperature markings .....      | 103 |
| 81   | Cautionary .....                | 104 |

## SUPPLEMENT SA - REQUIREMENTS FOR VENDING MACHINES INTENDED FOR INSTALLATION WITHIN MOTOR FUEL DISPENSING FACILITIES

|     |                                               |     |
|-----|-----------------------------------------------|-----|
| SA1 | Scope .....                                   | SA1 |
| SA2 | Definitions .....                             | SA1 |
| SA3 | General .....                                 | SA1 |
| SA4 | Marking .....                                 | SA2 |
| SA5 | Installation and Operating Instructions ..... | SA2 |

## APPENDIX A – OPERATING AND PROTECTIVE (“SAFETY CRITICAL”) CONTROL FUNCTIONS (Normative)

## INTRODUCTION

### 1 Scope

1.1 These requirements cover self-contained, payment-accepting, vending machines that vend non-refrigerated products to be employed in accordance with the National Electrical Code, ANSI/NFPA 70. Vending machines as covered by this standard are intended for indoor use only, except that they will be investigated for outdoor use or use in a protected location if so designated by the manufacturer. Vending machines may be battery operated. Vending machines may be battery operated and may be provided with a solar photovoltaic (PV) system. Refrigerated sections of vending machines that vend a non-refrigerated product are judged under the requirements for refrigerated vending machines.

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

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

### 2 Units of Measurement

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

### 3 Undated References

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

### 4 Terminology

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

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

## 5 Glossary

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

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

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

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

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

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

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

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

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

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

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

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

- a) Isolates ignition sources;
- b) Renders inaccessible all or any part(s) of the equipment that may otherwise present a risk of electric shock; or
- c) Retards propagation of flame initiated by electrical disturbances occurring within.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## CONSTRUCTION

### 6 General

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

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

6.3 A component shall:

- a) Comply with the safety standard covering that component;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability; and
- d) Comply with the applicable requirements of this end product standard.

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

- a) Involves a feature or characteristic not required in the application of the component in the product;*
- b) Is superseded by a requirement in this standard; or*
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.*

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

## 7 Nonmetallic Parts

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

7.2 In addition to the requirement in 7.1, nonmetallic materials that serve as electrical insulation or that directly support live parts shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

## 8 Nonmetallic Materials

8.1 Materials shall be classified with respect to flammability characteristics that are established by the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

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

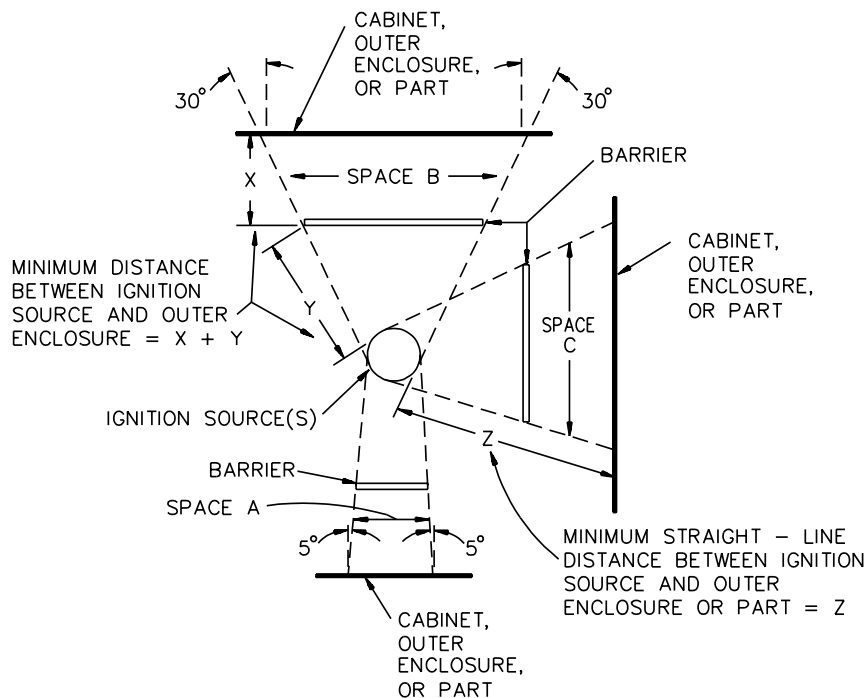
8.3 In reference to 8.2, the assigned flammability rating shall be appropriate for the material-use application in accordance with Nonmetallic Material Ignition Sources Separation, Section 9 and Table 74.1.

## 9 Nonmetallic Material Ignition Sources Separation

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

- a) Below an ignition source and within Space A;
- b) Above an ignition source and within Space B; and
- c) In the vertical plane relative to an ignition source and within Space C.

**Figure 9.1**  
**Separation of ignition sources from nonmetallic materials**



S2514C

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

- a) High-voltage wiring not employing VW-1 insulation and the HB or HBF materials shall be a minimum of 2 inches (51 mm); and
- b) Any other ignition source and the HB or HBF materials shall be a minimum of 4 inches (102 mm).

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

- a) Above the ignition source shall be as shown in Distance  $X + Y$ ; and
- b) In the vertical plane relative to the ignition source shall be as shown in straight-line Distance  $Z$ .

## 10 Nonmetallic Material Application and Location

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

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

## 11 Barriers

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

- a) Metal, minimum 0.005 inch (0.13 mm) thick;
- b) Fiberglass, minimum 0.5 inch (12.7 mm) thick;
- c) A nonmetallic material rated 5VA;
- d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, 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 Other than as specified in 19.1.4, 26.8 and 47.4(d) a nonmetallic barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 74.1.

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

## 12 Frame and Enclosure

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

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

- a) Mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Combustibility;
- e) Resistance to distortion at temperatures to which the material may be subjected under conditions of normal or abnormal usage; and

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

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

**Table 12.1**  
**Minimum acceptable thickness of enclosure metal**

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

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

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

a) Under a motor unless:

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

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

i) Open main winding;

ii) Open auxiliary winding; and

iii) Starting switch short-circuited; or

3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will prevent the temperature of the motor windings from exceeding:

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

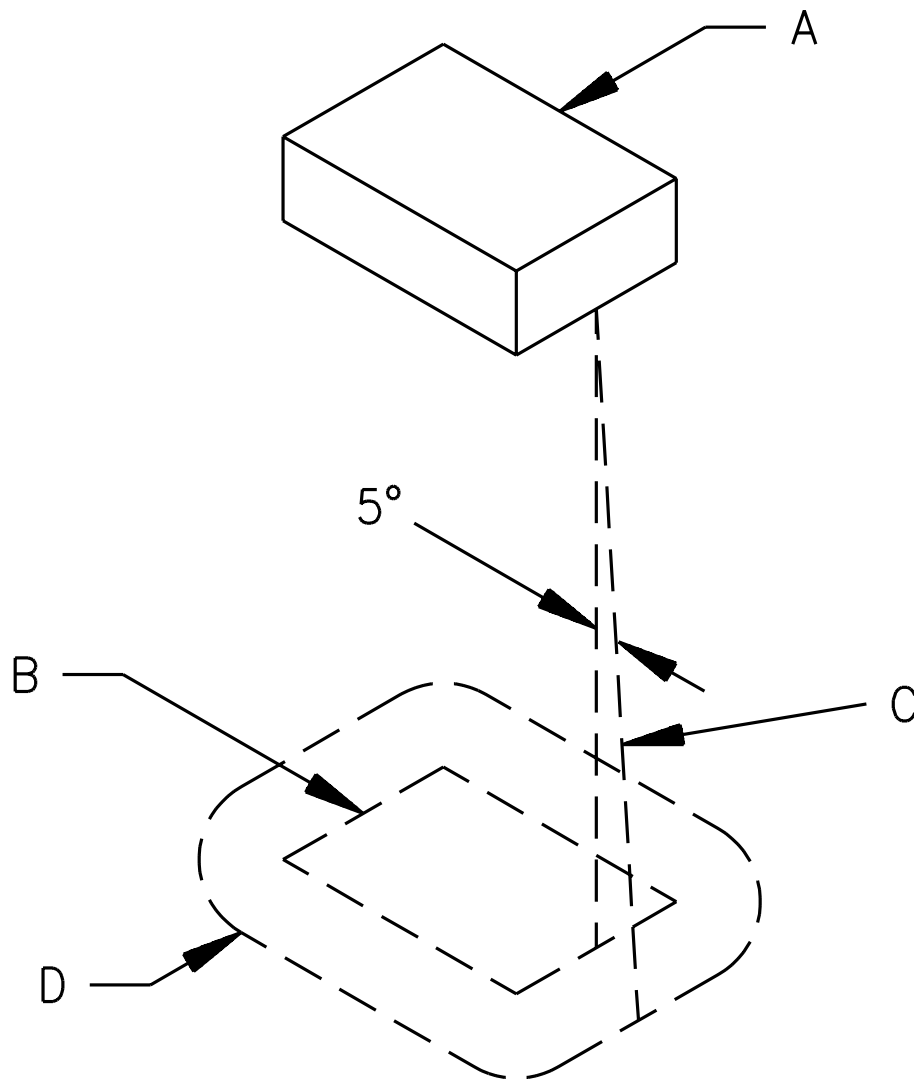
ii) 150°C (302°F) with the rotor of the motor locked.

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

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

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

**Figure 12.1**  
**Location and extent of barrier**



EB120A

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded, and will consist of the unshielded portion of a component that is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. When moving, the line is always tangent to the component, 5 degrees from the vertical, and so oriented that the area traced out on a horizontal plane is maximum.

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

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

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

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

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

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

- a) Electrical input;
- b) Temperature rise;
- c) Operation of overvoltage condition;
- d) Ability to withstand dielectric potential;
- e) Reliability of vapor seal;
- f) Resistance to moisture;
- g) Stability of conductive coating;
- h) Aging of terminal assemblies;
- i) Resistance to impact; and
- j) Resistance to thermal shock.

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

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

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

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

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

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

- a) Due to their location within the equipment; or
- b) By the placement of other components in the enclosure so that if the equipment cover is removed, the gasket will be reengaged in the intended manner when the cover is replaced.

### 13 Mechanical Assembly

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

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

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

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

- a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated – a toggle switch is considered to be subjected to forces that tend to turn the switch during normal operation of the switch;*
- b) The means of mounting the switch makes it unlikely that operation of the switch will loosen it;*
- c) Spacings are not reduced below the minimum acceptable values if the switch rotates; and*
- d) Normal operation of the switch is by mechanical means rather than by direct contact by persons.*

13.4 Uninsulated live parts and components that have uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position if such displacement could result in a reduction of spacings below the minimum values specified in Spacings, Section 46. See 13.3.

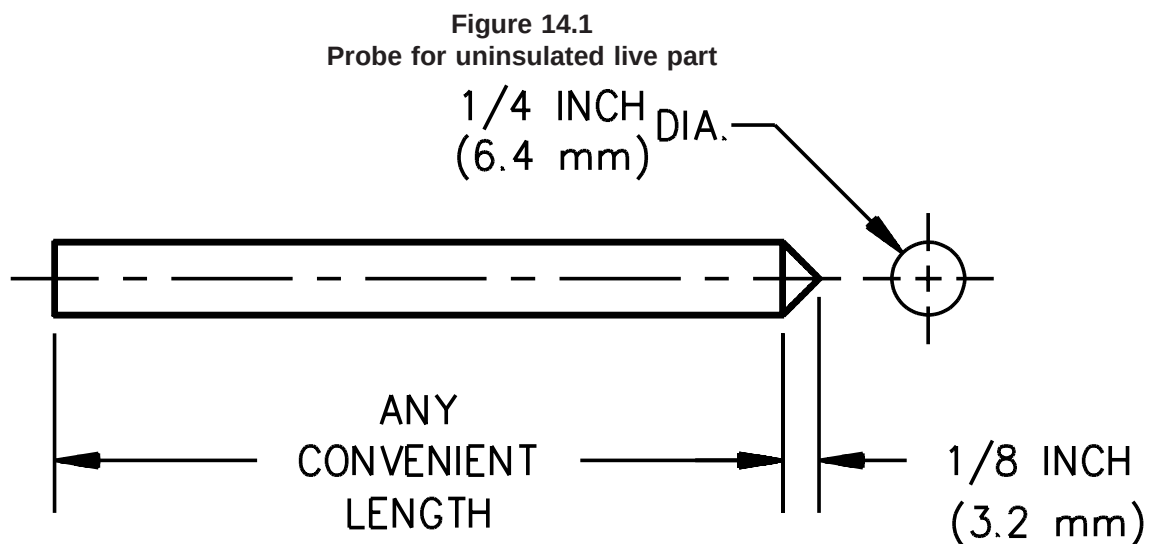
13.5 The means for preventing the turning or shifting mentioned in 13.3 and 13.4 shall consist of more than friction between surfaces – for example, a lock washer, properly applied, is acceptable as a means to prevent turning or shifting of live parts or a device having a single-hole mounting means.

## 14 Accessibility of Live Parts

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

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

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

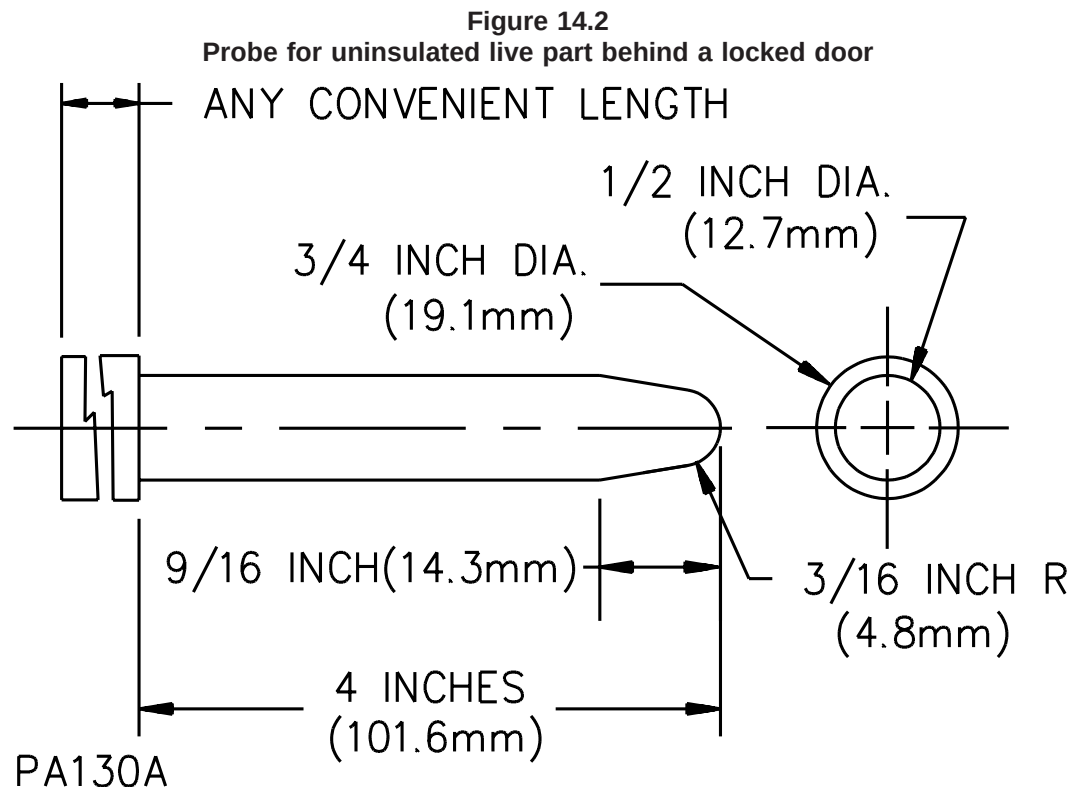


PA190

14.3 Behind a locked door, an opening:

- a) That will not permit entrance of a 3/4-inch (19.1-mm) diameter rod is acceptable if:
  - i) A probe as illustrated in Figure 14.2 cannot be made to touch any uninsulated live part when inserted through the opening; and
  - ii) A probe as illustrated in Figure 14.3 cannot be made to touch film-coated wire when inserted through the opening.

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



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

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**Figure 14.3**  
Probe for film-coated wire

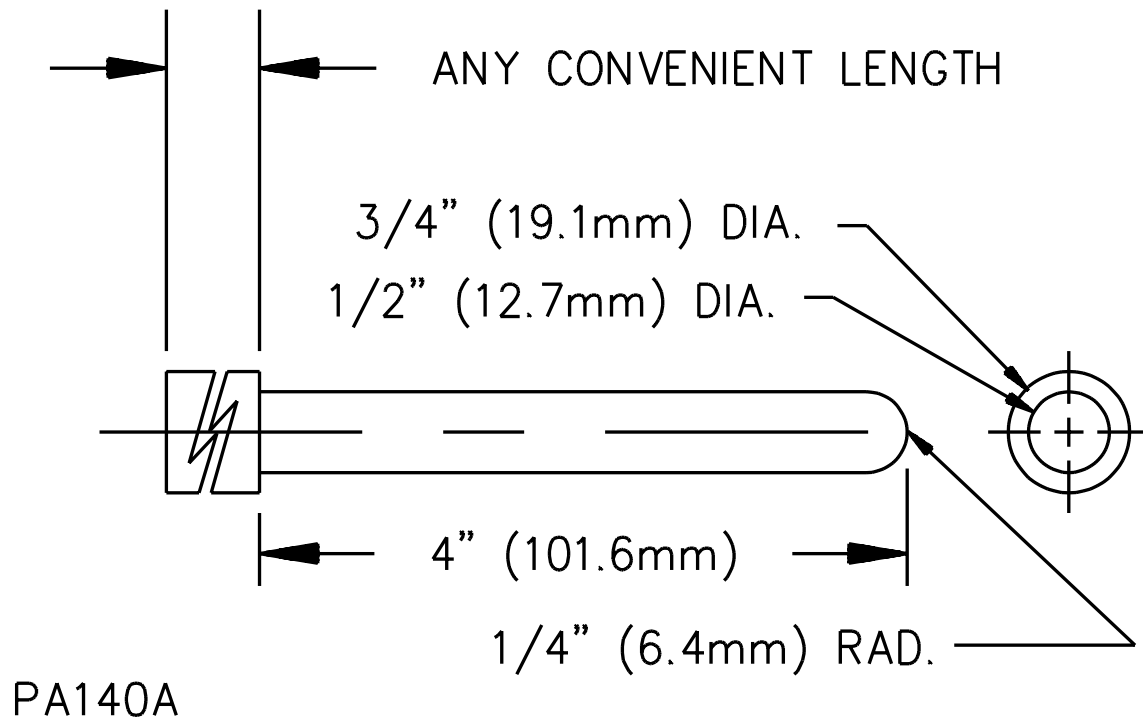
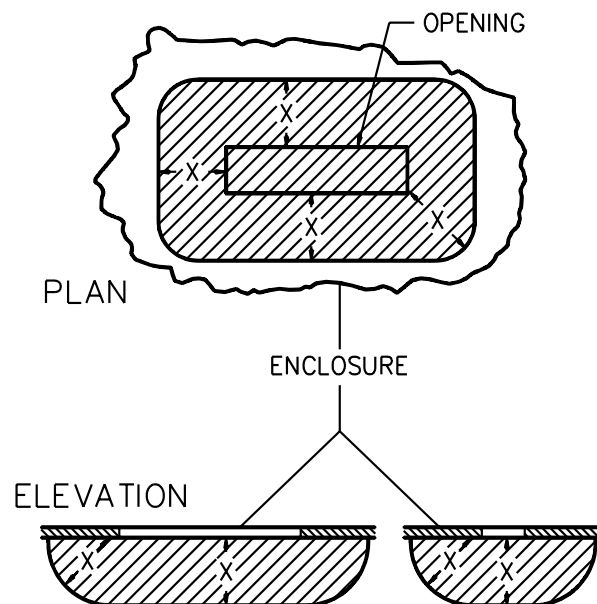


**Figure 14.4**  
**Opening in enclosure**  
Proportions Exaggerated for Clarity



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

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

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

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

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

## 15 Protection Against Corrosion

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

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

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

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

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

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

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

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

- a) Hot-dipped mill-galvanized sheet steel that complies with the coating Designation G60 or A60 in Table I of Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM designation. The weight of the coating is to be established using any method acceptable for the purpose. In case of question, the weight of coating is to be established in accordance with the test method of Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M.
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 in (10.4  $\mu\text{m}$ ) on each surface with a minimum thickness of 0.00034 in (8.6  $\mu\text{m}$ ). The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 64.
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The suitability of the paint is to be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

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

- a) Hot-dipped mill-galvanized sheet steel that complies with the coating Designation G90 in Table I of Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM designation. The weight of the coating is to be established using any method acceptable for the purpose. In case of question, the weight of coating is to be established in accordance with the test method of .
- b) A zinc coating, other than that provided on Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90Mn hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 in (15.5  $\mu\text{m}$ ) on each surface with a minimum thickness of 0.00054 in (13.7  $\mu\text{m}$ ). The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 64. An annealed coating shall also comply with the requirements in 15.7.
- c) A cadmium coating with a thickness not less than 0.001 in (25  $\mu\text{m}$ ) on both surfaces. The thickness of the coating is to be determined by the Metallic Coating Thickness Test, Section 64.
- d) A zinc coating that complies with 15.5(a) or (b) with one coat of outdoor paint – applied after forming – as specified in 15.5(c).
- e) A cadmium coating with a thickness not less than 0.00075 in (19.1  $\mu\text{m}$ ) on both surfaces with one coat of outdoor paint on both surfaces, or with a thickness not less than 0.0005 in (13  $\mu\text{m}$ ) on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating is to be determined by the Metallic Coating Thickness Test, Section 64 and the paint shall be as specified in 15.5(c).

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

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

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

## 16 Supply Connections For Cord Connected Vending Machines

### 16.1 Cords and plugs

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

16.1.2 In reference to 16.1.1, a power supply cord and plug shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

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

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

16.1.5 The GFCI shall comply with the Standard for Ground Fault Circuit Interrupters, UL 943 and be either:

- a) An integral part of the attachment plug; or
- b) Located such that it is in the supply cord within 12 in (305 mm) of the attachment plug.

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

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

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

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

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

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

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

- a) 60 Hz; and/or
- b) The voltages specified in 58.1.6.

**Table 16.1**  
**ANSI designation for attachment plug**

| Attachment plug rating                                                                                             | ANSI designation <sup>a</sup> |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------|
| 15 amperes, 125 volts                                                                                              | 5-15                          |
| 20 amperes, 125 volts                                                                                              | 5-20                          |
| 30 amperes, 125 volts                                                                                              | 5-30                          |
| 15 amperes, 250 volts                                                                                              | 6-15                          |
| 20 amperes, 250 volts                                                                                              | 6-20                          |
| 30 amperes, 250 volts                                                                                              | 6-30                          |
| <sup>a</sup> Designations in accordance with Standard For Wiring Devices – Dimensional Requirements, ANSI/NEMA WD6 |                               |

16.1.12 The power supply cord equipment grounding conductor shall be:

- a) Finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified;
- b) Secured to the frame or enclosure of the vending machine by a positive means that is not likely to be removed during any servicing operation not involving the power supply cord. A sheet metal screw or quick-connect terminal shall not be used; and
- c) Connected to the grounding blade of the attachment plug.

## 16.2 Strain relief

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

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

- a) Mechanical damage to the cord;
- b) Exposing the cord to a temperature higher than that for which it is rated;
- c) Reducing spacings, such as to a metal strain-relief clamp, below the minimum required values; or
- d) Damaging internal connections or components.

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

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

## 17 Supply Connections for Permanently Connected Vending Machines

### 17.1 General

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

- a) A vending machine rated more than 250 volts; or
- b) A polyphase vending machine.

### 17.2 Field-wiring compartments

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

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

## 17.3 Field-wiring terminals and leads

### 17.3.1 General

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

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

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

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

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

### 17.3.2 Terminals

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

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

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

17.3.2.4 Wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with 17.3.2.5 – 17.3.2.10 or with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

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

- a) Smaller than 8 (4.2 mm diameter) for 14 AWG (2.1 mm<sup>2</sup>) supply circuit conductors; or
- b) Smaller than 10 (4.8 mm diameter) for 12, 10, or 8 AWG (3.3, 5.3, or 8.3 mm<sup>2</sup>) supply circuit conductors.

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

*Exception: A plate not less than 0.030 inch (0.76 mm) thick is acceptable for 14 AWG (2.1 mm<sup>2</sup>) conductors.*

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

17.3.2.8 A wire-binding screw shall thread into metal.

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

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

### 17.3.3 Leads

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

- a) Be one of the types of wiring specified in 20.2.2;
- b) Be 6 inches (152 mm) or more in length, as measured from the lead end to the strain relief means, unless the use of a shorter lead is required to prevent damage to the lead insulation;
- c) Be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. Leads shall comply with 48.1 when subjected to a direct pull of 20 pounds-force (89 N);
- d) Not be connected to wire binding screws or pressure wire connectors located in the same compartment as the lead ends (that are intended for spliced connections to the field-wiring) unless the screws or connectors are rendered unusable for field-wiring connections or the lead ends are insulated; and
- e) Be insulated at the free end, if the lead will not be used in every installation and if the end can reduce spacings below the minimum acceptable values specified in High Voltage Circuits, Section 46.1 for high-voltage circuits or Low-Voltage Circuits, Section 46.2 for low-voltage circuits.

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

## 17.4 Equipment grounding

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

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

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

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

17.4.5 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked, "G," "GR," "GND," "Ground," "Grounding," or the like, or by a marking on a wiring diagram provided on the vending machine.

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

## 18 Current-Carrying Parts

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

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

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