UL 2438

STANDARD FOR SAFETY

Outdoor Seasonal-Use Cord-Connected Wiring Devices

UL Standard for Safety for Outdoor Seasonal-Use Cord-Connected Wiring Devices, UL 2438

Second Edition, Dated November 14, 2014

Summary of Topics

This revision of ANSI/UL 2438 dated December 6, 2022 includes reference to the Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, for a consistent approach for permanence of marking requirements for flag labels, flag tags, and wrap-around labels; 45.1 and 45.3

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 September 30, 2022.

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UL 2438

Standard for Outdoor Seasonal-Use Cord-Connected Wiring Devices

First Edition – June, 2006

Second Edition

November 14, 2014

This ANSI/UL Standard for Safety consists of the Second edition including revisions through December 6, 2022.

The most recent designation of ANSI/UL 2438 as a Reaffirmed American National Standard (ANS) occurred on December 6, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 The requirements of this Standard cover outdoor seasonal-use cord-connected wiring devices that are intended for temporary outdoor use – not to exceed 90 days – with outdoor equipment, Christmas-tree, and other seasonal decorative-lighting outfits. Some outdoor seasonal-use cord-connected wiring devices employ additional devices such as photoelectric sensors, fuses, supplementary protectors, timers, audio, flasher control or synchronized features. Products employing additional devices shall meet the intent and testing described in this Standard.

1.2 These requirements only cover devices of the 2-pole, 3-wire, 5-15 configuration as shown in Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6.

1.3 These requirements cover devices with remote control features that comply with the Standard for Solid-State Controls for Appliances, UL 244A. See Devices Employing Remote Control Features, Section 11. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

1.4 These requirements cover devices with audio features that comply with the Standard for Audio, Video, and Similar Electronic Apparatus – Safety Requirements, UL 60065, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1. See Devices Employing Audio Features, Section 12.

1.5 These requirements are intended to be used with the Standard for Cord Sets and Power-Supply Cords, UL 817.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

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

4 Undated References

4.1 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.

CONSTRUCTION

5 General

5.1 An outdoor seasonal-use cord-connected wiring device shall have a minimum length of 1.5 feet (0.48 m) and a maximum length of 50 feet (15.2 m) when measured in accordance with the Standard for Cord Sets and Power-Supply Cords, UL 817.

5.2 Switches are permitted between or on the end fittings. When a switch is provided, it shall be either a general-use snap switch that complies with the Standard for General-Use Snap Switches, UL 20, or a special-use switch that complies with the Standard for Special-Use Switches, UL 1054, or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1. The switch shall have a voltage and current rating suitable for the application. When the switch is used to control a load fitting, it shall be AC tungsten rated and have voltage and current ratings not less than the load it is intended to control. These requirements apply to all switching mechanisms, including, but not limited to, supplementary protectors being used as, and having a reset button in a similar shape as a switch actuator, or containing symbols, words, or letters meaning "ON/OFF".

5.3 The NEMA configurations of various attachment plug and receptacle combinations referenced in this standard are in accordance with Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6.

5.4 A blade used in an attachment plug cap shall comply with the Standard for Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords, UL 1659.

Exception No. 1: A blade which has crimp connections that are also soldered or welded need not comply with the performance requirements in the Standard for Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords, UL 1659.

Exception No. 2: A blade which is welded or is made mechanically secure and soldered directly to the conductor connections need not comply with the performance requirements in the Standard for Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords, UL 1659.

6 Flexible Cord

6.1 The flexible cord used in an outdoor seasonal-use cord-connected wiring device shall be of the size specified in Table 6.1. The cord shall comply with the Standard for Flexible Cords and Cables, UL 62, and shall have a minimum flame rating of VW-1 and minimum insulation temperature rating of 105°C (221°F). See 6.2 for cord types permitted.

6.2 The flexible cord used in an outdoor seasonal-use cord-connected wiring device shall be one of the following: SW, SOW, SOOW, STW, STOW, STOOW, SEW, SEOW, SJW, SJOW, SJOOW, SJTW, SJTOW, SJTOOW, SJEW, or SJEOW.

Table 6.1
Guide to construction and performance requirements for outdoor seasonal-use cord connected wiring devices

Device rating, A	Minimum power-supply cord size, AWG (mm^2)	Number of outlets	Overcurrent protection required?	Overcurrent protective device rating[a], A	Temperature test load (A)[d]	Minimum internal wiring size[b], AWG (mm^2)
15	12 (3.3)	Up to 6	No	15[c]	15	12 (3.3)
15	14 (2.1)	≤4	No	15[c]	15	14 (2.1)
15	14 (2.1)	Up to 6	Yes	15	15	14 (2.1)
13	16 (1.3)	Up to 6	Yes	13	13	16 (1.3)
Max 10	16 (1.3)	Up to 3	No	10[c, e]	13[c]	16 (1.3)

[a] An overcurrent protective device shall not trip when it is operated at the marked current.

[b] Smaller AWG is not prohibited from being used when an overcurrent protective device is provided and the results of the Fault Current Test, and the Component Temperature Test comply with the requirements of those tests using the smaller AWG wire.

[c] When provided with an overcurrent protective device, the Temperature Test load shall be equal to the overcurrent protective device and its rating.

[d] Test is capable of being conducted at the overcurrent protective device rating when provided.

[e] The overcurrent protective device rating can be lower but shall be equal to the device rating.

7 Fittings

7.1 An attachment plug, cord connector, or current tap, provided on an outdoor seasonal-use cord-connected wiring device shall be rated 15 A, 125 V and of the 2-pole, 3-wire, 5-15 configuration. In addition, the line fitting of an outdoor seasonal-use cord-connected wiring device may additionally provide integral overcurrent protection in accordance with Table 6.1. When fusing is provided, or when overcurrent protection is required as specified in 6.1, it shall be located either in the line fitting or within 6 inches (152 mm) of the line fitting. (See also Fittings Intended to Accommodate Fuses or Overcurrent Protection, Section 10).

7.2 An outdoor seasonal-use cord-connected wiring device employing an outlet fitting (a cord connector connected between the end fittings) shall comply with all of the following:

a) There shall not be more than a total of 6 outlets (including those provided at the end fittings); and

b) The outlet fittings shall be factory-assembled to the flexible cord and shall not be field-rewireable.

7.3 The voltage and current ratings (configurations) of the line and load fittings shall be equal.

7.4 A load fitting shall be either of the molded- or assembled-body type. The load fitting is to be provided with means for mounting such as, but not limited to, a minimum of 3/8-inch (9.5-mm) diameter mounting hole or detachable type stake with a minimum length of 12 inches (305 mm) and maximum length of 32 inches (813 mm). After completion of installation, the connector shall be maintained a minimum of 6 inches (152 mm) above ground. The mounting means shall not require the use of tools to remove. Installation instructions shall be provided describing the intended use and mounting means.

7.5 All assembled-on (non molded-on) fittings of an outdoor seasonal-use cord-connected wiring device shall comply with the construction requirements in the Standard for Attachment Plugs and Receptacles, UL 498.

7.6 Load fittings shall be provided with self-closing outlet closures.

7.7 A polymeric material used for electrical insulation or enclosure of live parts shall have a flame class rating of V-1, V-0, VTM-1, or VTM-0 in accordance with the requirements of the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The flame class rating of the material shall be judged at the minimum thickness employed at the walls and barriers in the device which are critical to the functioning of the insulation or enclosure of the device.

7.8 A polymeric material used for electrical insulation or enclosure of live parts shall have a Comparative Tracking Index (CTI) rating of 175 V or greater or a performance level class of at least 3.

Exception No. 1: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirement if it complies with the Comparative Tracking Index Test, Section 15.

Exception No. 2: A polymeric material used in an enclosure that is separated through air by more than 1/32 inches (0.8 mm) from uninsulated live parts and more than 1/2 inch (12.7 mm) from arcing parts is not required to comply with this requirement.

7.9 A polymeric material used for electrical insulation or enclosure of live parts shall have Hot Wire Ignition (HWI) and High-Current Arc Resistance to Ignition (HAI) ratings or performance level classes of at least those shown in Table 7.1 for the flame class rating determined in accordance with 7.7. For materials with other than VTM flammability classifications, the HWI and HAI ratings of the material shall be evaluated using the specimen thickness employed in the end product or nominal 1/8-inch (3.2-mm) thickness, whichever is greater.

Exception No. 1: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with the HWI requirements if it complies with the Glow Wire Test, Section 16.

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with the HAI requirements if it complies with the High-Current Arc Resistance to Ignition Test, Section 17.

Table 7.1
Electrical properties of insulating materials

Flammability classification[a]	HWI PLC[b]	HAI PLC[c]	CTI[d]
V-0, VTM-0	3	3	3
V-1, VTM-1	3	3	3

[a] Flammability Classification – Described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

[b] Hot Wire Resistance to Ignition Performance Level Category – Described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

[c] High-Current Arc Resistance to Ignition Performance Level Category – Described in UL 746A.

[d] Comparative Tracking Index – Described in UL 746A.

7.10 A polymeric material having values 0, 1, 2 or 3 as specified in Table 7.1 are not required to be subjected to the tests described in 7.9. For materials whose electrical properties have not yet been determined, the tests described in Sections 15 – 17 shall be conducted.

7.11 A polymeric material used for electrical insulation or enclosure of live parts shall have the Relative Thermal Index (RTI) rating of 60°C as described in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

7.12 All fittings shall be resistant to sunlight and mechanical abuse in accordance with the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C.

7.13 A solidly molded-on fitting shall exclude moisture by adhering tightly to the jacket of the cord at the point that the jacket or the cord enters the plug as determined by 7.14 and 7.15.

7.14 To determine the adhesion between the cord and the body of the fitting, the cord is to be bent sharply to an angle of 90 degrees with the plane of the cord entry and visually examined for openings that might permit the entry of moisture into the body.

7.15 If the visual examination called for in 7.14 is unable to verify that acceptable adhesion exists, but there is reason to suspect that an acceptable seal may exist between the cord and the plug at some concealed location within the plug, the representative power-supply cords may be cut apart for examination. The adhesion may be determined to be acceptable if the examination of the inner construction reveals a positive seal at all points around the periphery of the cord.

8 Drain Openings

8.1 An enclosure body shall be constructed to prevent the accumulation of water on live parts, electrical components or conductors not identified for use in contact with water.

8.2 An enclosure body that permits water to enter the unit during the Rain and Sprinkler Test, Section 27, shall be provided with a drain hole.

8.3 Drain holes, if provided, shall be located in the surface likely to prevent the accumulation of water.

8.4 Drain holes shall permit the insertion of 0.125-inch (3.2-mm) diameter rod.

8.5 Drain holes shall have a barrier to prevent contact with live metal parts by an object that may be used to clear drain hole.

9 Gaskets

9.1 A gasket or bushing required to prevent water from entering the enclosure shall be secured to prevent its loosening by a clip, clamping ring, adhesion, or other mechanical means.

9.2 A gasket shall have a minimum temperature rating of 60°C (140°F).

9.3 The adhesive used to secure a gasket or bushing that is required to prevent water from entering the enclosure, and which is likely to be exposed or not compressed as intended during user maintenance, shall comply with the Gasket Adhesion Test, Section 29:

a) For the gasket adhesive combination only; or

b) With the gasket installed.

10 Fittings Intended to Accommodate Fuses or Overcurrent Protection

10.1 The enclosure of an overcurrent protective device (OCP) shall comply with the material requirements in 7.7.

10.2 Integral overcurrent protection (short circuit and overload protection), if provided, shall be rated in accordance with Table 6.1.

10.3 The integral overcurrent protective device shall also comply with the Standards for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14.

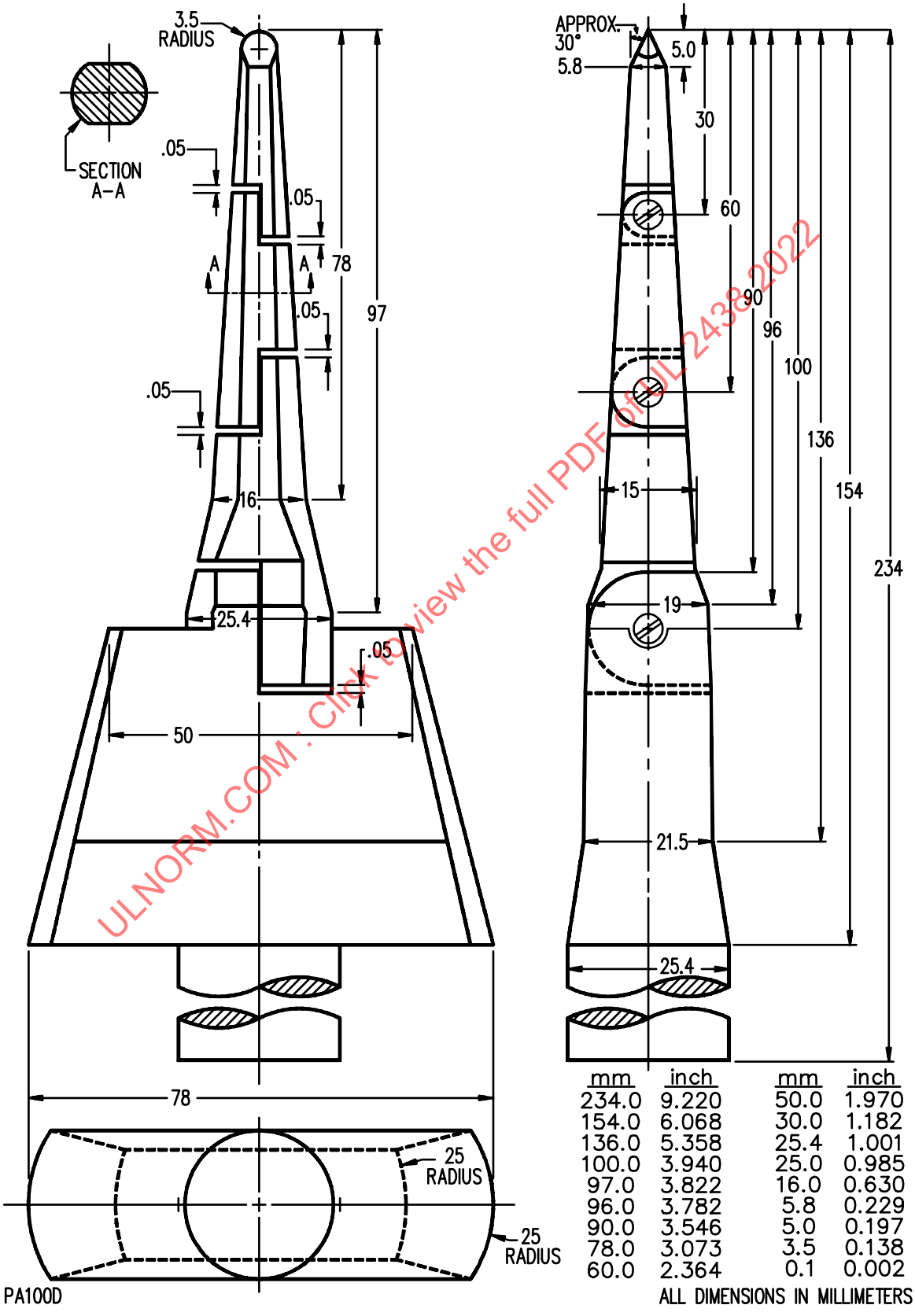
10.4 The overcurrent protective device, other than that required by 6.1, may be located in the attachment plug, in the outlet(s), or between the attachment plug and the outlet(s) and shall be connected to the ungrounded conductor. Supplementary overcurrent protection (short circuit and overload protection) is an acceptable method of providing the protection required by 6.1, however, thermal cutouts, thermal relays, and other devices not intended to open short circuits, shall not be used.

10.5 A fused attachment plug or load fitting shall be constructed so that there shall not be exposure of live parts during removal or replacement of the fuse, nor exposure of live parts with the fuse cover partially open while the plug or current tap is inserted 0.08 inch (2.03 mm) into a receptacle. Exposure of live parts shall be determined by contact with the accessibility probe illustrated in Figure 10.1.

10.6 The overcurrent protective device shall have a minimum short-circuit rating of 1000 A and shall be of the replaceable or manually resettable type. A replaceable fuse shall be of a readily available type to reduce the likelihood of the plug being replaced with one that is unfused. The overcurrent protective device shall not be of the automatic resetting type.

Figure 10.1

Articulate probe with web stop



mm	inch	mm	inch
234.0	9.220	50.0	1.970
154.0	6.068	30.0	1.182
136.0	5.358	25.4	1.001
100.0	3.940	25.0	0.985
97.0	3.822	16.0	0.630
96.0	3.782	5.8	0.229
90.0	3.546	5.0	0.197
78.0	3.073	3.5	0.138
60.0	2.364	0.1	0.002

ALL DIMENSIONS IN MILLIMETERS

11 Devices Employing Remote Control Features

11.1 In addition to the requirements of this standard, devices employing remote control features shall comply with the Standard for Solid-State Controls for Appliances, UL 244A. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

11.2 The electrical tungsten rating shall be greater than or equal to the device rating.

11.3 The output shall not only be controlled by the remote controller. A separate individual switch/interface shall be provided on the main body as a secondary on/off control.

11.4 A device employing a remote control feature shall be marked in accordance with 45.4 and 45.5.

12 Devices Employing Audio Features

12.1 In addition to the requirements of this standard, devices employing audio features shall comply with the Standard for Audio, Video, and Similar Electronic Apparatus – Safety Requirements, UL 60065 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1. See Devices Employing Audio Features, Section 12.

12.2 The current rating of the audio portion shall be considered in the overall rating of the device.

13 Devices Employing Synchronized Features

13.1 The electrical rating shall be greater than or equal to the rating of the device.

13.2 For a device that can be switched between sustaining output and synchronized output, an indicator shall be provided when the device operates at synchronized mode. The device shall be started up only at sustaining output mode.

13.3 A device employing synchronized features shall be marked in accordance with 45.6.

13.4 Synchronized outlets shall be marked as noted in 45.6 and each synchronized outlet shall be rated a minimum of 2.4 amps.

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14 Representative Devices

14.1 Unless stated otherwise, six representative outdoor seasonal-use cord-connected wiring devices are to be used for each test.

14.2 All outdoor seasonal-use cord-connected wiring devices are to be subjected to the tests described in Sections 15 – 42 of this Standard and the specified tests contained in the Standard for Cord Sets and Power-Supply Cords, UL 817, as outlined in Table 14.1. When additional components are employed, additional tests such as the Component Temperature Test, Section 43, are required.

Table 14.1
Tests conducted on outdoor seasonal-use cord-connected wiring devices

Reference	Test
Section 15	Comparative Tracking Index
Section 16	Glow Wire
Section 17	High Current Arc Resistance to Ignition
Section 18	Mold Stress Relief
Section 19	Moisture Absorption Resistance
UL 817	Dielectric Voltage-Withstand
UL 817	Insulation Resistance
UL 817	Accelerated Aging
Section 20	Conductor Secureness
Section 21	Leakage Current
Section 22	Leakage Current Following Humidity Conditioning
UL 817	Impact Resistance
UL 817	Improper Insertion
Section 23	Fuseholder Temperature
Section 24	Fuseholder Crush
Section 25	Fuseholder Cover
Section 26	Strain Relief
Section 27	Rain and Sprinkler
Section 28	Gasket
Section 29	Gasket Adhesion
Section 30	Ultraviolet (UV)-Light Exposure
UL 817	Low-Temperature Insertion
Section 31	Impact
Section 32	Cold Impact
Section 33	Resistance to Crushing
Section 34	Adhesive
Section 35	Calibration
Section 36	Fault Current
UL 817	Security of Blades/Contacts
UL 817	Blade Pull at Elevated Temperature
UL 817	Abrupt Pull
UL 817	Jacket Retention
UL 817	Water Exclusion (for enclosures of outdoor-use products)
Section 37	Retention of Plugs
Section 38	Overload
Section 39	Temperature
Section 40	Retention of Plugs (Repeated)
Section 41	Resistance to Arcing
Section 42	Grounding Contact
Section 43	Component Temperature Test

15 Comparative Tracking Index Test

15.1 A polymeric material used for electrical insulation or enclosure of live parts evaluated in accordance with Exception No. 1 of 7.8 and tested in accordance with the Comparative Tracking Index and Comparative Tracking Performance Level Class of Electrical Insulation Materials Test described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, shall have a performance level class value not greater than 3.

16 Glow Wire Test

16.1 A polymeric material used for electrical insulation or enclosure of live parts and evaluated in accordance with Exception No. 1 of 7.9 shall be tested in accordance with the requirements of 16.2 in order to determine its resistance to ignition from overheated conductors caused by circuit overloads.

16.2 Devices are to be subjected to the Glow-Wire End-Product Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. As a result of this test, there shall not be ignition of the insulating material during 30 seconds of application of the probe at a glow-wire temperature of 650°C (1202°F) for all devices.

17 High-Current Arc Resistance to Ignition

17.1 A polymeric material used for electrical insulation or enclosure of live parts and evaluated in accordance with Exception No. 2 to 7.9 when tested as described in 17.2 – 17.4 shall not ignite within the number of arcs specified in Table 17.1 for the flame class of the insulating material. In addition, there shall not be dielectric breakdown caused by formation of a permanent carbon conductor path.

Exception No. 1: An insulating material used in the face of a female outlet device that has been subjected to the Resistance to Arcing Test described in Section 41, as appropriate, is not required to be subjected to this test.

Exception No. 2: An insulating material that has previously been accepted for use in the face of a female outlet device as specified in Exception No. 1 may be judged acceptable for use in other applications without being subjected to this test.

Table 17.1
High-current arc resistance to ignition test arcing criteria

Flame class	No. of arcs
V-1, VTM-1	15
V-0, VTM-0	15

17.2 When preparing devices for test, the condition that will cause the greatest arcing near the material being tested in the device is to be simulated as follows:

a) If the live parts are in direct contact with the polymeric material or located less than 1/32 inch (0.8 mm) from the polymeric material, the moving electrode is to be positioned on the surface of the material. The test arc is to be established between a live part acting as the fixed electrode and any adjacent part where breakdown is likely to occur. For example, if the material being tested is used in the face of an attachment plug, one line blade is to be connected to the test circuit as the fixed electrode.

b) If the live parts are located at least 1/32 inch (0.8 mm) but less than 1/2 inch (12.7 mm) from the material, both the fixed and moving electrodes are to be positioned above the surface of the material at a distance equal to the minimum spacing between the live part and the material.

17.3 The test circuit is to provide test currents and test voltages equal to the current and voltage ratings of the device to be tested, but not exceeding 30 A or 240 V ac in any case. The test arc is to be established between a fixed electrode and a moving electrode consisting of a copper or stainless steel conductive probe. Each device is to be positioned with the electrodes making initial contact. The circuit is to be energized and the cyclic arcing started. The electrodes are to be drawn apart a distance not exceeding either 3/64 inches (1.2 mm) for a device rated 250 V or less and 1/8 inch (3.2 mm) for a device rated more than 250 V. The arc is to be used to attempt to ignite materials forming parts of the enclosure or to ignite materials located between the parts of different potential. The moving electrode is to be used to break through insulation, create arc tracking or create a carbon build-up across the surface of the insulating material at a rate of 30 to 40 arc separations per minute.

17.4 Immediately following the completion of the arcing portion of the test, the device is to be subjected to a Dielectric Voltage Withstand Test as described in the Standard for Cord Sets and Power-Supply Cords, UL 817.

18 Mold Stress Relief Test

18.1 As a result of temperature conditioning specified in 18.2, there shall not be any warpage, shrinkage or other distortion that results in any of the following:

a) Making uninsulated live parts, other than exposed wiring terminals, or internal wiring accessible to contact, by the probe illustrated in Figure 10.1.

b) Defeating the integrity of the enclosure so that acceptable mechanical protection is not afforded to the internal parts of the device.

c) Interference with the operation, function or installation of the device. The outlet slot openings of a female device shall be capable of receiving a fully inserted attachment plug of the intended configuration.

d) A condition that results in the device not complying with the strain relief requirements, if applicable.

e) A reduction of spacings between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal below the minimum acceptable values.

f) Any other evidence of damage that could increase the risk of fire or electric shock.

Exception: Devices employing only thermosetting materials are not required to be subjected to this test, including thermosetting elastomeric materials such as neoprene (chloroprene butadiene) rubber (CBR), ethylene/propylene/diene (EPDM), natural rubber (NR), nitrile rubber (NBR), styrene (butadiene) rubber (SBR), and silicone rubber (SIR).

18.2 The devices are to be placed in a circulating air oven maintained at a temperature of 70°C (158°F) for 7 hours. The devices are to be removed from the oven and allowed to cool to room temperature before determining compliance.

18.3 Immediately following the completion of this test, the devices are to be subjected to a repeated Dielectric Voltage-Withstand Test as described in the Standard for Cord Sets and Power-Supply Cords, UL 817.

19 Moisture Absorption Resistance Test

19.1 Moisture-resistant insulating materials shall not absorb more than 6 percent of water by mass.

19.2 The material is to be:

a) Dried at 105°C ± 5°C for 1 hour;

b) Weighed (W1);

c) Immersed in distilled water at 23°C ± 1°C for 24 hours;

d) Removed from the distilled water and the excess surface moisture wiped off; and

e) Reweighed (W2).

The moisture absorbed by the material is to be calculated as:

$$\frac{W_2 - W_1}{W_1} \times 100\,\%$$

Exception: A material tested in accordance with Test Method for Water Absorption of Plastics (ASTM D 570) described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, is not required to be tested.

20 Conductor Secureness Test

20.1 If a conductor of a flexible cord is connected to an element (male blade or female contact) of a fitting before the element has been assembled to the fitting, each connection shall withstand for 1 minute, without breaking, a pull of 20 lbf (89 N). The pull is to be applied in a direction normal to the plane of the cord-entry hole. As a result of the test, the conductors shall not be displaced more than 1/16 inch (1.6 mm) from the point of entry into the device. The test is to be conducted prior to the assembly of the blades or contacts in the device.

20.2 While the test in 20.2 is being performed, the angle between the element and the cord conductor is to be the same as in the completely assembled fitting. The test shall be performed by using dead weights or, at the manufacturer's option, a power driven tensile testing machine. If a tensile testing machine is used it shall have jaws suitable for holding the specimen and capable of applying the minimum required tensile load to the specimen while separating at a uniform rate not exceeding 1 inch/minute (25.4 mm/min). The machine shall be equipped with a scale from which the load can be read to a value of 0.1lbf (0.4 N). The accuracy of the scale shall be within ±2 percent of the value read, and weights shall be provided for calibrating the machine.

21 Leakage Current Test

21.1 When tested as described in 21.2 – 21.8, the leakage current of an outdoor seasonal-use cord-connected wiring device shall not be more than 0.5 mA.

21.2 Leakage current refers to all currents, including capacitively-coupled currents, that may be conveyed between exposed conductive surfaces of the device and ground or other exposed conductive surfaces.

21.3 All exposed conductive surfaces of a device shall be tested for leakage current. A conductive surface is considered to be exposed unless it is guarded by an enclosure which reduces the risk of electric

shock. The leakage currents from these surfaces are to be measured to the grounded (neutral) supply conductor individually as well as collectively, if simultaneously accessible, and from one surface to another, if simultaneously accessible. Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time.

21.4 If an insulating material, with or without a metallized coating, is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 4 by 8 inches (10 by 20 cm) in contact with accessible surfaces of insulating material. If the accessible surface of insulating material is less than 4 by 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 product. The accessible parts are to be tested individually, collectively, and from one part to another.

21.5 The measurement circuit for leakage current is to be as illustrated in Figure 21.1. The measurement instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for the particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

a) The meter shall have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 μF.

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

c) Over a frequency range of 0 – 100 kHz, the measurement circuitry shall 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 μF capacitor to 1500 ohms. At an indication of 0.5 mA, the measurement shall have an error of not more than 5 percent at 60 Hz.

21.6 Unless the meter is being used to measure leakage current from one part of the device to another, the meter shall be connected between the accessible parts and the grounded supply conductor.

21.7 One device is to be tested for leakage current starting with the as-received condition. The device is considered to be in the as-received condition prior to energization, except as may occur as part of the production-line testing. The supply voltage is to be adjusted to 125 V. The test sequence, with reference to the measuring circuit illustrated in Figure 21.1, is to be as follows:

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

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

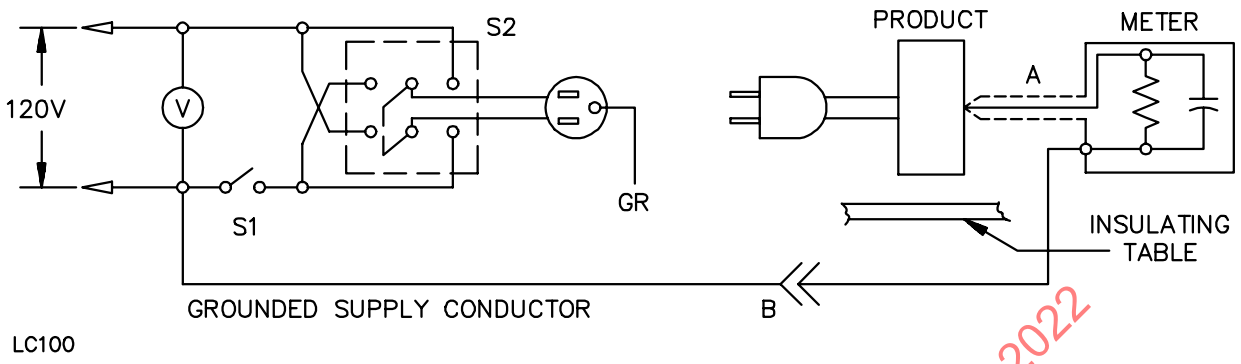
c) The leakage current is to be monitored to determine the maximum leakage current from the time of previous measurement until operating temperatures are obtained. Both positions of switch S2 are to be used in determining this measurement.

Exception: Products which have been subjected to the Rain and Sprinkler Test, Section 27, are only required to comply with (a) and (b).

21.8 A device is to be carried through the complete Leakage Current Test program as specified in 21.1 without interruption for other tests. With the concurrence of those concerned, the Leakage Current Test may be interrupted for the purpose of conducting other nondestructive tests after the leakage current has stabilized.

Figure 21.1

Leakage-current measurement circuit



Notes:

A – Probe with shielded lead.

B – Separated and used as clip when measuring currents from one part of the motor-operated device to another.

22 Leakage Current Following Humidity Conditioning

22.1 An outdoor seasonal-use cord-connected wiring device shall comply with the requirements for leakage current contained in 21.1 of the Leakage Current Test, Section 21, following exposure for 48 hours to air having relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (90 ±4°F).

22.2 To determine whether a device complies with the requirements in 22.1, one device is to be heated to a temperature just above 34°C (93°F) to reduce the likelihood of condensation of moisture during conditioning. The heated device is to be placed in the humidity chamber and is to remain for 48 hours under the conditions specified in 22.1.

22.3 Following the conditioning, the device is to be tested, without load current flowing, as described in 21.7(a), either in the humidity chamber or immediately after removal of the conditioned device from the humidity chamber. Note that moisture in the air condensing on the conditioned device surfaces after removal from the chamber can invalidate the test results. After the test, without load current flowing, the device is to be energized and tested as described in 21.7 (b) and (c). For each test, the maximum leakage current is to be recorded and the test is to be discontinued when the leakage current stabilizes or decreases.

23 Fuseholder Temperature Test

23.1 When tested as described in this section, the temperature rise of an in-line fuseholder or an attachment plug or product incorporating a fuseholder shall not exceed the following:

a) 85°C (153°F) on the fuse clips;

b) 30°C (54°F) at the wiring terminals or cord connections;

c) The relative thermal index of the surrounding insulating material, minus an assumed ambient of 25°C (77°F); and

d) 60°C (108°F) on any exposed exterior surface.

23.2 The test is to be conducted on a set of six previously untested devices. The test is to be conducted with a live fuse.

Exception: If the live fuse opens at the rated fuse current, in the fuseholder to be tested, twice before temperatures are stabilized as indicated in 23.6, a dummy fuse may be employed for temperature testing in accordance with 23.8 and 23.9. The dummy fuse is to be made from a copper tube, identical to the length of the live fuse and diameter of the contact area of the live fuse.

23.3 The devices are to be wired in a series circuit with the blades of the attachment plug, power inlet, or current tap connected by the shortest possible length of solid copper wire soldered across the blades. For an attachment plug or current tap intended for use with flexible cord, each connection to the fuseholder being tested is to be made by means of a 6-inch (150-mm) or shorter length of the appropriate type of flexible cord that has an ampacity at least equal to that of the device. For a male inlet, Type RH or Type TW lead-in wires no more than 6 inches (150 mm) long are to be connected to the wiring terminals. Wire of the intended ampacity is to be used regardless of the size of the cord which is intended to be used with the device.

23.4 Temperatures are to be measured by means of thermocouples attached to the fuse clips, the insulating material of the device body in proximity to the fuseholder, and the wiring terminals or cord connections and the exterior exposed surfaces.

Exception: If the wiring terminals or cord connections are not accessible for mounting thermocouples, the thermocouples are to be attached to the blades as close as possible to the face of the device.

23.5 The thermocouples are to consist of 28 – 32 AWG (0.08 – 0.032 mm^2) iron and constantan wires. It is a common practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires with a potentiometer type of indicating instrument. This equipment shall be used if a referee measurement of temperature is necessary.

23.6 The device is to be connected to a supply circuit of 125 V and a frequency of 60 Hz. The device is then to be operated continuously for a minimum of 3 hours, under representative intended service conditions that are likely to produce the highest temperature, until constant temperatures are attained. Constant temperatures are considered to exist when three consecutive readings, taken at 15 minute intervals, are within 1°C (1.8°F) of each other and indicate no further rise above the changes in ambient temperature.

23.7 Each device is to be tested with the rated fuse intended for use with the device installed and subjected to a test current described in Table 6.1. A current tap shall have 15 A of test current through the female contacts and blades in addition to the test current in the fuse circuit specified above.

23.8 If the test is to be conducted with a dummy fuse in accordance with the Exception to 23.2, each device is to be subjected to a test current equal to the intended maximum ampere rating of the intended fuse. The correlation testing described in 23.9 is to be performed on the dummy fuse and the live fuse to determine the temperature correction factor. To represent the heating of a live fuse, the correction factor is to be added to the recorded temperature rise on the wiring terminals, cord connections, surrounding insulating materials, conductors, fuse clips, and exterior surfaces.

23.9 The dummy fuse and live fuse are to be tested in the fuseholder under identical conditions. In order to allow the live fuse to reach temperature stabilization without opening in the fuseholder, it may be

necessary to remove the fuse cover, provide ventilation openings in the fuseholder, or both. Any modifications are also to be made to the dummy fuseholder. The difference in measured temperatures between the live fuse and the dummy fuse is the temperature correction factor.

24 Fuseholder Crush Test

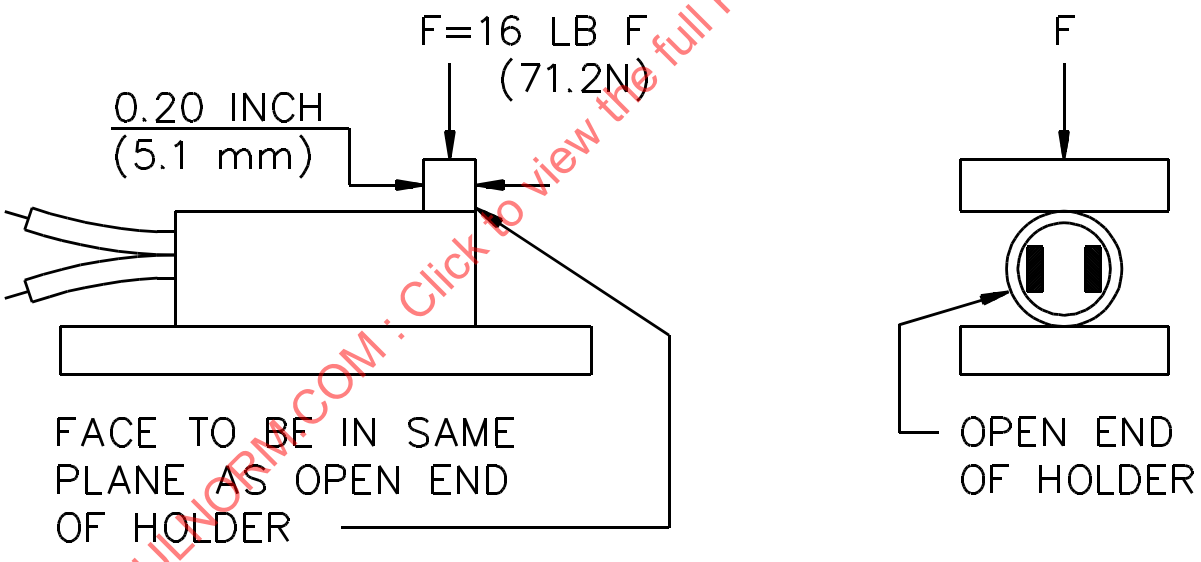
24.1 As a result of the test described in 24.2, there shall not be any cracking of the fuseholder or exposure of live parts as determined by contact with the accessibility probe illustrated in Figure 10.1.

Exception: A fuse incorporated in an attachment plug is not required to comply with this requirement.

24.2 Each of three fuseholders is to be tested. Each fuse is to be removed from each fuseholder. The fuseholder is then to be placed between two flat surfaces parallel to each other and parallel to the major axis of the holder. A force of 16 lbs (71.2 N) is to be applied perpendicular to the major axis of the holder and to the plane of the flat surfaces for 1 minute. For holders with open ends for fuse insertion, the force is to be applied over a distance of 0.20 inch (5.1 mm) as measured from the open end of the holder. See Figure 24.1.

Figure 24.1

Crush test on open-end lampholder



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25 Fuseholder Cover Test

25.1 When subjected to a force of 8 lbs (36 N) applied for 1 minute to an open cover in any direction that the cover may be removed, the open cover of a fuseholder, fused attachment plug, or current tap, or similar device, shall not detach from the body of the device. One fuseholder is to be tested.

26 Strain Relief Test

26.1 A pull exerted on a cord shall not be transmitted directly to the terminals of a fitting.

Exception: This test is not required for constructions that are subjected to the Abrupt Pull Test described in Standard for Cord Sets and Power-Supply Cords, UL 817.

26.2 The assembly of the cord to a fitting shall be capable of withstanding a straight pull of 30 lbf (133 N), applied between the fitting and the cord.

Exception: A through-cord assembly is to be tested cord-to-cord with the switch in between. The conductors of the cord shall not become detached from the terminal of the fitting.

26.3 The fitting is to be securely supported by a rigid, flat plate mounted horizontally. The plate is to have a hole just large enough for the supply cord to pass through. A pull of 30 lbf (133N), as specified in 26.2, is to be applied by means of a weight for 1 minute to the flexible cord, in a direction perpendicular to the plane of the cord-entry hole for a device other than a through-cord switch.

Exception: A fitting that has the major axis of its blades perpendicular to the plane of the cord-entry opening may be supported by the blades when the test is conducted.

27 Rain and Sprinkler Test

27.1 Test method – general

27.1.1 Three representative outdoor seasonal-use cord-connected wiring devices that are intended to be used in wet locations shall be subjected to the rain test described in 27.2 and the sprinkler test described in 27.3. Compliance criteria is described in 27.4.

Exception: The rain test and sprinkler test are not required when the construction features of the unit are such that it is readily apparent that water does not enter the unit during its intended use.

27.1.2 An outdoor seasonal-use cord-connected wiring device shall be positioned in the most severe position permitted by its base and any adjustment means.

27.1.3 An outlet shall have an attachment plug-cap plugged into the connector for the duration of the test.

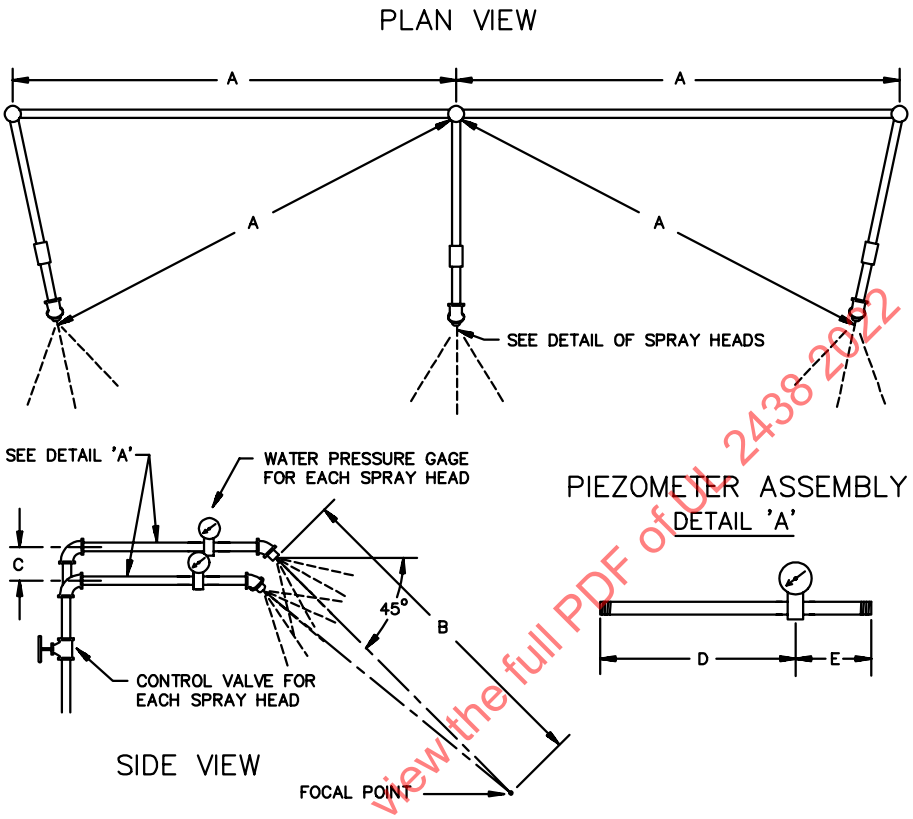
27.1.4 Immediately following the rain or sprinkler test, the outdoor seasonal use cord-connected wiring device shall be subjected to the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Leakage Current Test, Section 21.

27.2 Test method – rain test

27.2.1 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 27.1. Spray heads are to be constructed in accordance with the details shown in Figure 27.2. Each fitting is to be set up as in a normal installation when so intended. The enclosure is to be positioned in the focal area of the spray heads so that the greatest quantity of water enters the enclosure. The water pressure is to be maintained at 5 lbs/in^2 (34.5 kPa) at each spray head.

Figure 27.1

Rain-test spray-head piping



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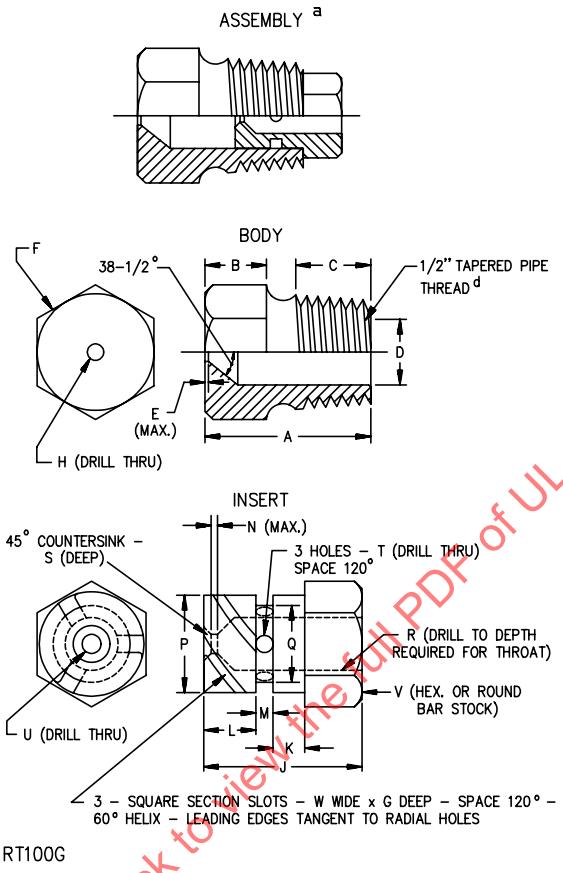
Item	inch	(mm)
A	28	(710)
B	55	(1400)
C	2-1/4	(55)
D	9	(230)
E	3	(75)

Figure 27.2

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)	W	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.

[d] ANSI/ASME B1.20.1

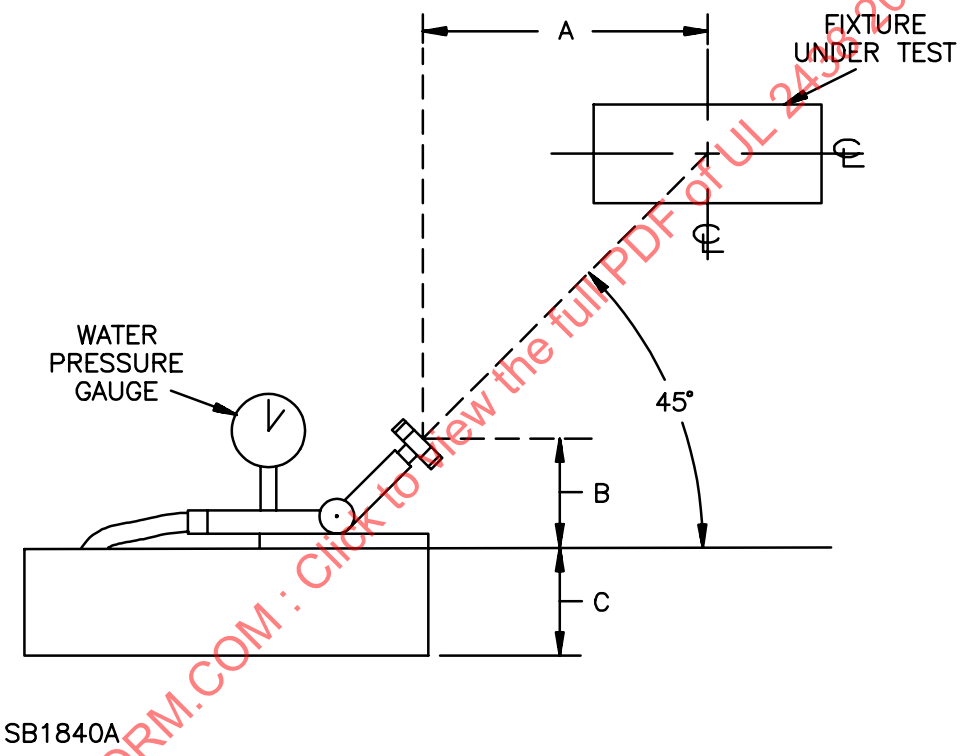
27.3 Test method – sprinkler test

27.3.1 Each fitting is to be turned about its vertical axis to each of four positions 90 degrees from each other, each for 30 minutes during the 2 hour portion of the test described in 27.3.2, with adjustable parts arranged for maximum vulnerability to the water spray.

27.3.2 Each fitting is to be positioned, as shown in Figure 27.3 in front of the standard water spray head of the type shown in Figure 27.2 to which the water pressure is maintained at a gauge pressure of 20 pounds per square inch (137.9 kPa).

Figure 27.3

Representative sprinkler test setup



a) 36 inches (914 mm).

b) 3 – 6 inches (76.2 – 152 mm).

c) Height required for the unit to be mounted as intended with the dimensional center of the unit on a line projected from the center line of the nozzle head.

27.4 Test results

27.4.1 Test results meet the intent of the requirements when after the rain or sprinkler tests, no water has entered the outdoor seasonal-use cord-connected wiring device and the unit is found to comply with the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Leakage Current Test, Section 21.

Exception: A unit provided with a drain hole as required by Drain Openings, Section 8, is not required to comply with this requirement.

28 Gasket Test

28.1 After the conditioning described in 28.2, a gasket intended to provide a water seal shall have a tensile strength of not less than 60 percent and an elongation of not less than 75 percent of the values determined before conditioning.

28.2 A total of 12 gaskets are needed for this test. Three are to be tested for elongation in the as-received condition and three are to be tested for tensile strength in the as-received condition. Six are to be placed in a circulating-air oven at a temperature of 60°C (144°F) for 168 hours. Three of the conditioned gaskets are to be tested for elongation and the other three are to be tested for tensile strength. The test methods and apparatus are described in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension, ASTM D 412.

29 Gasket Adhesion Test

29.1 When tested as described in 29.2 – 29.4, a gasket secured by adhesive and intended to provide a water seal shall have an adhesion force of not less than 60 percent of the value determined before conditioning.

29.2 A total of 9 representative gaskets are to be tested.

29.3 Three gaskets are to be tested in the as-received condition. Six gaskets are to be placed in a circulating-air oven at a temperature 80°C (144°F) for 168 hours.

29.4 The force required to remove the gasket from its mounting surface is the adhesion force and is to be measured by pulling the gasket strip from the test panel at an angle of approximately 90 degrees and a crosshead speed of 0.5 inches/minute (12.7 mm/minute). Three are to be tested in the as-received condition, three are to be tested 1/2 hour after removal from the oven, and three are to be tested 24 hours after removal from the oven.

30 Ultraviolet (UV) Light Exposure Test

30.1 General

30.1.1 After being tested as described in 30.2, the polymeric material employed as an enclosure of a seasonal product intended for outdoor use or as part of an attachment plug, fuseholder, controller, load fitting, splice compartment, or similar device employed in a product intended for outdoor use shall comply with both of the following:

a) The flammability classification of the unconditioned material shall not be reduced as a result of the UV conditioning described in 30.2. The flammability classification is to be determined according to the flammability requirements for polymeric enclosures contained in 7.7. The portion of the material having the thinnest wall thickness is to be tested. All colors under consideration are to be tested; and

b) The product shall be subjected to the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, the Leakage Current Test, Section 21, the Rain and Sprinkler Test, Section 27, the Cold Impact Test, Section 32, the Resistance to Crushing Test, Section 33, and the Security of Blades Test described in UL 817, as applicable.

Exception No. 1: For a material found to comply with UV testing of the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746C, this test is not required.

Exception No. 2: Polymeric material molded as a decorative part employed in an outdoor seasonal use cord set is not required to be subjected to these tests.

30.1.2 After the UV conditioning, the Cold Impact Test, Section 32, is to be conducted except that the product is to be impacted with a force equal to 70 percent of the initial force. After the immersion conditioning, the Cold Impact Test is to be conducted at 50 percent of the initial values.

30.2 UV conditioning

30.2.1 Each unit is to be exposed to ultraviolet light and water spray by using either of the following apparatus:

a) Twin enclosed carbon-arc, Type D, in accordance with ASTM G 23, Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials. Exposure Method 1, continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 20 minutes consisting of a 17 minute light exposure and a 3 minute exposure to water spray with light, is to be used. The apparatus is to operate with a black-panel temperature of 63 ±3°C (145.4 ±5.4°F), or

b) Xenon-arc, Type B, in accordance with ASTM G 26, Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials. Exposure Method 1, continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 minutes consisting of a 102 minute light exposure and an 18 minute exposure to water spray with light, is to be used. The apparatus is to operate with a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2 nm at 340 nm and a black-panel temperature of 63 ±3°C (145.4 ±5.4°F).

30.2.2 The units are to be mounted vertically on the inside of the cylinder in the ultraviolet-light apparatus, with the width of the unit facing the arcs so that they do not touch each other.

30.2.3 Two sets of units are to be exposed. For twin enclosed carbon-arc, one set is to be exposed for a total of 360 hours and the second set for a total of 720 hours. For xenon-arc, one set is to be exposed for a total of 500 hours and the second set for a total of 1000 hours. After the test exposure, the units are to be removed from the test apparatus, examined for signs of deterioration such as crazing or cracking, and retained under conditions of ambient room temperature and atmospheric pressure for not less than 16, nor more than 96 hours, before being subjected to the flammability and physical tests described in 30.1.1. For comparative purposes, units that have not been exposed to ultraviolet light and water are to be subjected to these tests at the same time that the final exposed units are tested.

30.2.4 If a material is to be considered in a range of colors, units representing these ranges are also to be provided. Units in the natural (if used in this color) and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. An additional set of units is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (for example, red, yellow, or similar colors) are known to have particularly critical effects, they are also to be provided.

31 Impact Test

31.1 After being tested as described in 31.2 and 31.3, an outdoor seasonal-use cord-connected wiring device shall comply with all of the following:

a) There shall not be any visible damage to the enclosure of the unit that would result in the exposure of live parts as determined by contact with the accessibility probe illustrated in Figure 10.1;

b) There shall not be any cracking or denting of the enclosure of the unit that would affect the function of any safety controls or constructional features such as overcurrent protective devices, waterseals, or strain relief, or result in the exposure of live parts increasing the risk of injury to persons;

c) There shall not be any damage to the enclosure of the unit that would result in an increase in the risk of electric shock as determined by compliance with the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Leakage Current Test, Section 21.

31.2 Each of the previously untested devices is to be subjected to a single impact. The impact is to be produced by dropping or swinging a 2-inch (50.8-mm) diameter steel sphere, weighing 1.18 lbs (0.535 kg) from a height which will produce an impact of 5 ft-lbs (6.8 J). The unit is to be rigidly supported and the impact is to be made normal to the most vulnerable spots on the unit enclosure that may be exposed to a blow during intended use. The steel sphere is to strike a different surface of the unit for each impact. For surfaces other than the top of an enclosure, either the unit is to be supported on the side and subjected to the impact mentioned above, or the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through the vertical distance necessary to cause it to strike the surface with the specified impact. Refer to Figure 31.1 with respect to the ball drop impact test or to Figure 31.2 for the ball pendulum impact test.

31.3 With reference to Figure 31.1 and Figure 31.2, the "H" designation represents the vertical distance the sphere must travel to produce the desired impact. For the pendulum impact, the sphere is to contact the test unit when the string is in the vertical position. The supporting surface for the ball drop impact is to be as described in 31.4. The supporting surface for the pendulum impact is to consist of any rigid surface. The backing surface for the pendulum impact is to consist of 3/4-inch (19-mm) plywood over a rigid surface of concrete or an equivalent nonresilient backing surface may be used.

31.4 The hardwood surface is to consist of a layer of nominal 1-inch (25-mm) tongue-and-groove oak flooring (actual size 3/4 by 2-1/4 inch or 18 by 57 mm) mounted on two layers of nominal 3/4-inch (19-mm) plywood. The assembly is to rest on a concrete floor or an equivalent non-resilient floor during the test.

Figure 31.1

Ball drop impact test

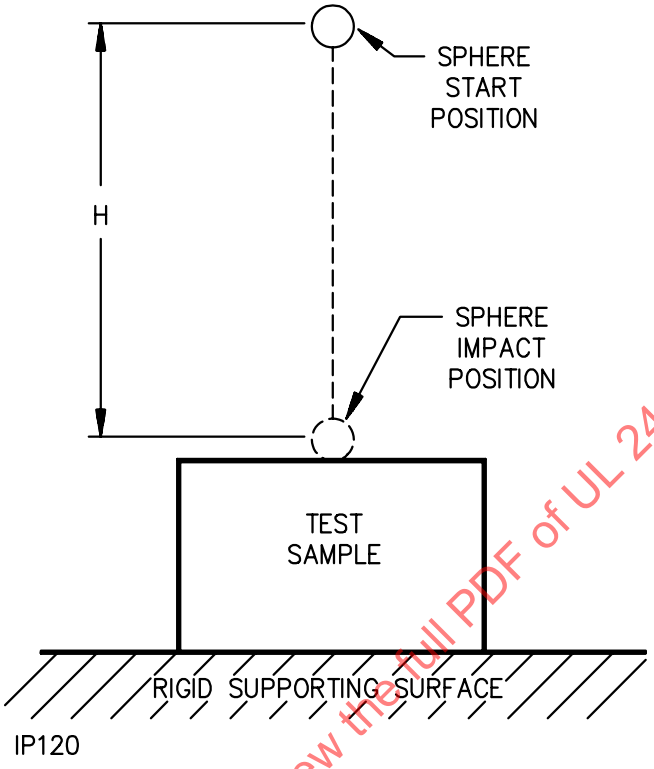
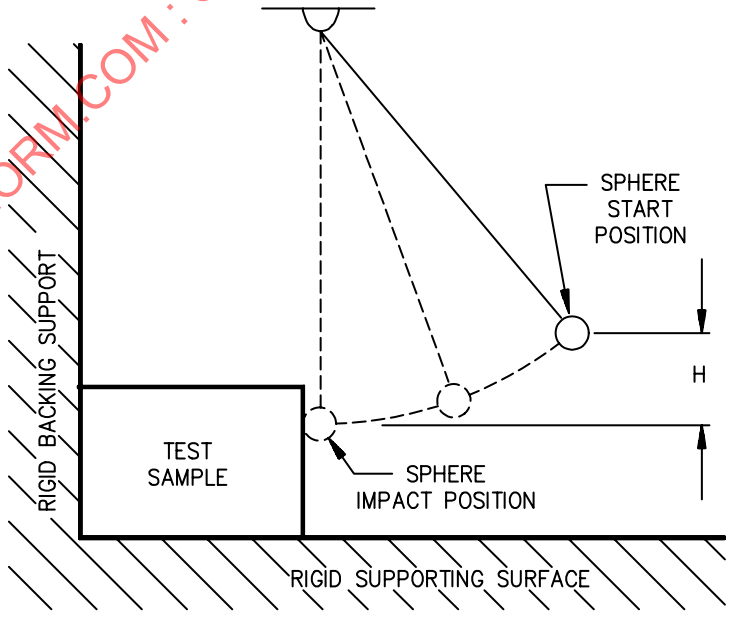


Figure 31.2

Ball pendulum impact test



32 Cold Impact Test

32.1 In addition to the Impact Test, Section 31, an outdoor seasonal-use cord-connected wiring device shall comply with all of the following after being tested as described in 32.2:

a) There shall not be any visible damage to the enclosure of the unit that would result in the exposure of live parts as determined by contact with the accessibility probe illustrated in Figure 10.1;

b) There shall not be any cracking or denting of the enclosure of the unit that would affect the function of any safety controls or constructional features such as thermostats, overload protective devices, waterseals, or strain relief, or result in the exposure of moving parts capable of causing injury to persons;

c) There shall not be any damage to the enclosure that would result in the increase of the risk of electric shock as determined by compliance with the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Leakage Current Test, Section 21.

32.2 Each of the previously untested devices is to be cooled to a temperature of -35.0 ±2.0°C (-31.0 ±3.6°F) and maintained at this temperature for a period of 4 hours minimum. Within 30 seconds of removal from the chamber, the units are to be subjected to the Impact Test, Section 31.

33 Resistance to Crushing Test

33.1 After being tested as described in 33.2, an outdoor seasonal-use cord-connected wiring device shall comply with each of the following:

a) There shall not be any visible damage to the enclosure of the unit that would result in the exposure of live parts as determined by contact with the accessibility probe illustrated in Figure 10.1;

b) There shall not be any cracking or denting of the enclosure of the unit that would affect the function of any safety controls or constructional features such as thermostats, overload protective devices, waterseals, or strain relief, or result in the exposure of moving parts increasing the risk of injury to persons;

c) There shall not be any damage to the enclosure of the unit that would result in an increase in the risk of electric shock as determined by compliance with the Dielectric Voltage-Withstand Test described in the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Leakage Current Test, Section 21.

33.2 Six previously untested devices are to be subjected to a steady crushing force of 75 lbs (334 N) for one minute. The unit is to be mounted between two parallel, flat, maple blocks, each not less than 1/2-inch (12.7-mm) thick. One block is to contain slots into which the blades of the unit, if provided, are to be fully inserted. The crushing force is to be applied gradually in a direction normal to the mounting surface.

34 Adhesive Test

34.1 An outdoor seasonal-use cord connected wiring device that employs an enclosure or part of an enclosure that is held together by adhesive is to be subjected to this test. After the conditioning described in 34.2, there shall not be breakdown of the adhesive to the extent that parts of the product can be readily separated.

34.2 A device is to be placed in a circulating-air oven for a period of fourteen days at a temperature of 90 ±1.0°C (194 ±1.8°F) or 10°C (18°F) above the maximum operating temperature of the enclosure, whichever is higher. After removal from the oven, the device is to be placed in a humidity chamber that has been adjusted for 88 ±5 percent humidity at 32.0 ±2.0°C (89.6 ±3.6°F) for 7 days. Upon removal from the chamber, the device is to be examined to determine compliance with 34.1.

35 Calibration Test

35.1 When tested in its holder as described in 35.2, an overcurrent protective device employed in an outdoor seasonal-use cord-connected wiring device set shall open:

a) Within 60 minutes when carrying 135 percent of its rated current, and

b) Within 2 minutes when carrying 200 percent of its rated current.

35.2 Each of six representative overcurrent protective devices is to be subjected to this test. One device in its holder is to be connected in series with a 125 V ac, 60 Hz supply source, a variable resistor, and an ammeter. A switch is to be placed across the overcurrent protective device to short it out of the circuit while the resistor is adjusted to supply a test current equal to 135 percent of the device's rating. The switch is then to be opened and the test current is to be monitored for 60 minutes or until the device opens, causing the current to stop flowing. The test is to be repeated on 2 of the 5 remaining devices. The test is then to be repeated on the three remaining devices at a current equal to 200 percent of the device's rating, for 2 minutes or until the device opens.

36 Fault Current Test

36.1 When an overcurrent protective device and holder employed in an outdoor seasonal-use cord-connected wiring device is tested as described in 36.2, there shall not be ignition of cotton.

36.2 Each of six representative fuse assemblies is to be subjected to this test. A 125 V ac, 60 Hz supply source is to be connected in series with a calibrated circuit and a 20 A time-delay fuse. The calibrated circuit is to be adjusted to supply a test current of 200 A at a power factor of 0.75 to 0.80 without the assembly under test or the time-delay fuse in the circuit. One fuse is to be inserted into its holder and connected in series with the supply source, the calibrated circuit, and the fuse. Cotton is to be placed around the assembly. If the fuse is located within an attachment plug or current tap, the blades of the device are to be inserted into a receptacle and cotton is to be placed around the body of the device, not in contact with its face. The circuit is to be energized and the test current is to be monitored until the fuse opens, causing the current to stop flowing. The test is to be repeated on 2 of the 5 remaining assemblies. The test is then to be repeated at a current of 1000 A on the three remaining assemblies.

37 Retention of Plugs Tests

37.1 The contacts of a 5-15R configuration outlet shall retain an attachment plug so that a force greater than 3 lbf (13 N) is required to withdraw the plug when tested as described in this section.

Exception: An outlet that has provision for locking the plug in place after the blades have been inserted in the female contacts (such as a rotating collar) is not required to be subjected to this test.

37.2 Each of six devices is to be subjected to ten conditioning cycles of insertion and withdrawal of a standard solid-blade attachment plug that has American National Standard detent holes in accordance with Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6, in rigidly mounted blades, following which the plug is to be fully reinserted into the device. The mating plugs are to have a 1-15P configuration. A pull of 3 lbf (13 N) in a direction perpendicular to the plane of the face of the cord connector and tending

to withdraw the plug from the device is then to be applied to the plug for 1 minute. The displacement of the plug shall not be greater than 0.079 inch (2 mm).

38 Overload Test

38.1 An outlet shall be capable of performing acceptably when subjected to the current overload test as described in 38.2. There shall not be any electrical or mechanical failure of the device, opening of a line or grounding fuse, welding of the contacts, nor burning or pitting of the contacts that would affect the intended function of the device.

38.2 The test current shall be 150 percent of the rated current of the device. For devices with standard configurations rated 125 V, illustrated in Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6, the test is to be conducted on direct current. All other devices with standard configurations denoted as "AC" are to be tested on alternating current. Whenever alternating current is used for the test, the power factor of the load is to be from 0.75 to 0.80.

Exception: A test on alternating current is not required when equivalent results have been obtained from a direct potential that is equal to or greater than the alternating-potential rating.

38.3 The fuse in the grounding conductor is to be 15 A. The fuse in the test circuit is to have the next higher standard fuse rating than the value of the test current.

38.4 The potential of the test circuit is to be from 95 to 105 percent of the rating of the device in volts.

38.5 Each of six devices is to be tested by machine or manually by inserting and withdrawing an attachment plug having rigidly secured solid blades that are connected through a flexible cord to a load. The mating plugs shall have a 5-15P configuration. When an equipment-grounding connection is provided in the device being tested, a grounding-type attachment plug is to be used and the grounding blade of the plug connected to the grounding contact of the device being tested. The grounding contact is then to be grounded through a fuse as specified in 38.3.

38.6 The test machine is to withdraw and insert an unrestricted attachment plug with an average velocity of 30 ±3 inches/s (760 ±75 mm/s) in each direction during a 2-1/2 inch (64 mm) stroke measured from the fully inserted position. The velocity is to be determined without the outlet device installed on the machine to eliminate restrictions on the plug motion.

38.7 The device is then to make and break the required test load for 50 cycles of operation at a rate no faster than 10 cycles per minute. The blade of the attachment plug is to mate with the female contact of the device for no more than 1 second.

38.8 Blades or contacts are not to be adjusted, lubricated, or otherwise conditioned before or during either test. The attachment plug used for either test may be changed after 50 cycles.

38.9 In the event that unacceptable results are obtained in the machine testing described in 38.6, referee tests may be conducted manually under conditions similar to those described in 38.6.

39 Temperature Test

39.1 The temperature rise of an outlet measured at the points described in 39.2 shall not be more than 30°C (54°F) when the device is carrying its maximum rated current.

39.2 Each of six devices is to be tested. Temperatures are to be measured by means of thermocouples attached to the wiring terminals or cord connections.

Exception: When the wiring terminals or cord connections are not accessible for mounting thermocouples or when the device does not have any wiring terminals, the thermocouples are to be attached to the blades of the mated attachment plug as close as possible to the face of the device

39.3 The temperature test is to be made following the overload test on the devices and is to continue for 4 hours or until stabilized temperatures are attained. A temperature is considered to be stabilized when three consecutive readings, taken at 5-minute intervals, indicate no further rise above the ambient temperature.

39.4 The generation of heat from sources other than the female contacts is to be minimized as much as possible. Each connection to the device being tested is to be made by means of a 12-inch (300-mm) or greater length of the appropriate type of flexible cord that has an ampacity at least equal to that of the device. The wire size and type are to be determined using the appropriate value for the device's current rating from Table 400.5(A) or 400.5(B) of the National Electrical Code, ANSI/NFPA 70.

39.5 The contacts of the device being tested are to be connected together by means of a mated attachment plug. The mating plugs shall have a 5-15P configuration. The plug is to have rigidly attached solid blades, and the terminals of the plug are to be short-circuited by means of the shortest feasible lengths of flexible cord as described in 39.4.

39.6 The terminals are to be tightened to the marked torque limit or, when a tightening torque is not provided, the torque used is to be 9 in-lbf (1.0 N·m) for devices rated 15 A or less and 14 in-lbf (1.6 N·m) for other ratings.

39.7 Temperature readings are to be obtained by means of thermocouples consisting of 28 – 32 AWG (0.08 – 0.03 mm^2) iron and constantan wires. It is a common practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires with a potentiometer type of indicating instrument. This equipment is to be used when a referee measurement of temperature is necessary.

40 Retention of Plugs Test (Repeated)

40.1 General

40.1.1 After completion of the Overload Test, Section 38, and the Temperature Test, Section 39, the contacts of the outlet shall retain an attachment plug so that when tested as described in this section:

a) A force greater than 3 lbf (13 N) is required to withdraw the plug, and

b) A force of 15 lbf (67 N) is capable of withdrawing the plug.

Exception: A cord connector that has provision for locking the plug in place after the blades have been inserted in the female contacts (such as a rotating collar) is not required to be subjected to this test.

40.2 Plug retention

40.2.1 Each of six devices is to be tested. A standard solid-blade attachment plug that has American National Standard detent holes, in accordance with Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6, in rigidly mounted blades is to be fully inserted into the device. The test plugs are to have the configuration of 1-15P. A pull of 3 lbf (13 N) in a direction perpendicular to the plane of the face of the cord connector and tending to withdraw the plug from the device is then to be applied to the plug for 1 minute. The displacement of the plug shall not be greater than 0.079 inch (2 mm).

40.3 Plug withdrawal

40.3.1 Each of six devices is to be tested. Following the application of the 3 lbf (13 N), the pull is to be increased to 15 lbf (67 N), using test plugs having the configuration of 5-15P, and the plug shall be withdrawn by the force.

41 Resistance to Arcing Test

41.1 If a material is used in the construction of the face of an outlet in a way that the material is likely to be exposed to arcing while in service, the devices that were subjected to 50 cycles of operation in the Overload Test, Section 38, shall perform acceptably when subjected to an additional 200 cycles of operation under the overload-test conditions following the temperature test and the repetition (if required – see 37.2) of the retention-of-plugs and gripping tests. There shall not be any indication of electrical tracking, formation of a permanent carbon conductive path or ignition of the material. The attachment plug used for this test may be changed after every 50 operations.

41.2 Alternatively, one set of devices may be subjected to the 50 cycles of operation in the Overload Test, Section 38, followed by the temperature test on the devices and then, to determine resistance to arcing, a second, previously untested set of devices may be subjected to 250 cycles of operation under the overload-test conditions.

42 Grounding Contact Test

42.1 Grounding outlets are to be subjected to the tests in this section.

42.2 Previously untested devices are to be used. Each device is to be mounted with its face in a vertical plane.

42.3 With the outlet oriented to create the maximum contact displacement (possible distortion of contact affecting its contact ability), the test pin A, Figure 42.1 is to be fully inserted in the grounding contact. A 5 lb (1.27 kg) weight is to be gradually suspended form the test pin 6 inches (152 mm) from the face of the outlet. The weight is to be applied for 1 minute, following which, the weight is to be removed. The application of the weight is to be repeated with the outlets rotated 90, 180 and 270 degrees for a total of four applications. Usually the test is started with the grounding pin opening directly above, below or on either side of the line slots.