UL 2238

STANDARD FOR SAFETY

Cable Assemblies and Fittings for Industrial Control and Signal Distribution

UL Standard for Safety for Cable Assemblies and Fittings for Industrial Control and Signal Distribution, UL 2238

Third Edition, Dated October 2, 2018

Summary of Topics

This revision of ANSI/UL 2238 dated December 5, 2024 includes Overload/Resistance to Arcing testing for either AC or DC General Use Disconnecting under load conditions; 24A.4, 24A.4A, 24A.5, 24A.5A, and 40.1.6

Text that has been changed in any manner or impacted by ULSE'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 November 1, 2024.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover devices intended for inter-connection of equipment, sensors, and actuators in remote-control, signaling, and power-limited circuits. Included are cable assemblies and fittings, feeder-tap cable systems, feed-through connectors, multi-outlet fittings, panel-mount fittings, and splitters. These devices are rated not more than 60 A and not more than 600 V.

1.1.1 These devices are not intended for disconnect means and are marked as described in 40.1.6.

1.1.2 Devices may be investigated for use as a disconnecting means under load conditions, if so requested and the device complies with the overload, temperature, resistance to arcing and dielectric voltage withstand testing as described in Table 18.1.

1.2 This standard also contains Supplement SA – Short Circuit Current Rated (SCCR) Cable Assemblies and Fittings for Industrial Control and Signal Distribution.

1.3 Unless otherwise noted, all devices are intended for indoor use.

1.4 These devices are for use on alternating current, direct current, or both.

1.5 The cable assembly fittings and panel-mount fittings are intended to be installed in accordance with the manufacturer's installation instructions. The cable assembly fittings are intended to be assembled or molded on flexible cord.

1.6 Each type of device covered by this standard is described in generic terms where practicable. Reference to use locations identified in the National Electrical Code or specific applications are omitted unless they are required for the identification of the device type. Such additional information is included in the applicable standards for the end-use product involved or in markings for the device.

1.7 This standard does not cover male-to-male cable assemblies with the exception of Class 2 circuits.

1.8 This standard does not directly apply to the following but may supplement other applicable standards:

a) Devices produced integrally with flexible cord or cable that are covered by the Standard for Cord Sets and Power-Supply Cords, UL 817;

b) Devices intended for connection to the branch circuit, such as attachment plugs, cord connectors, receptacles, inlets, and outlets, that are covered by the Standard for Attachment Plugs and Receptacles, UL 498;

c) Devices solely intended for direct connection to the branch circuit in accordance with the National Electrical Code, NFPA 70, and that are provided with contacts of the pin and sleeve type, covered by the Standard for Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type, UL 1682;

d) Devices intended to interconnect industrial machinery and to be installed in accordance with the Electrical Standard for Industrial Machinery, NFPA 79 that are covered by the Outline of Investigation for Multi-point Interconnection Power Cable Assemblies For Industrial Machinery, UL 2237;

e) Connectors intended for use in Data, Signal, Control and Power Applications within and between electrical equipment and intended for factory assembly as covered by the Standard for Component

Connectors for Use in Data, Signal, Control and Power Applications, UL 1977; and the Standard for Telephone Equipment, UL 1459, or the Standard for Communications Circuit Accessories, UL 1863;

1.9 Fittings and devices that employ surge protective devices and/or circuitry to provide surge protection of internal functionality, in addition to complying with the requirements of this standard, shall also comply with the construction and performance requirements for Type 4 component assemblies or for Type 5 components, as appropriate, in accordance with the Standard for Surge Protective Devices, UL 1449.

1.10 Fittings and devices that are intended to provide surge protection of connected equipment and wiring, in addition to the requirements of this standard, shall also be evaluated to the requirements (including ratings and markings) for either Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449.

2 Glossary

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

2.2 CABLE ASSEMBLY – A length of flexible cord or cable with an male cable fitting as a line fitting and a female cable fitting as a load fitting.

2.2A CLASS 2 CIRCUIT – A control circuit supplied from a source having limited voltage (30 V rms (42 V peak) or less, such as from the secondary of a Class 2 transformer, and rated for use with Class 2 remote-control or signaling circuits. The potential shall not be greater than 15V rms (21.2 V peak) under conditions where wet access may occur, including products identified for use outdoors.

2.3 CORD or CABLE TAG – An adhesive backed label that is wrapped around the cord or cable and secured to itself forming a flag that protrudes from the cord or cable. A label without adhesive that is secured to the cord or cable using a securement strap such as a cable tie is also consider a cord tag.

2.4 CURRENT-CARRYING CONDUCTOR – A cord conductor excluding both the grounding conductor and the neutral conductor.

2.5 ENCLOSURE – That part of the device that renders inaccessible all or any parts of the device that otherwise present a risk of electric shock, propagate of flame initiated by electrical disturbances occurring within, or both.

2.6 FEEDER-TAP CABLE SYSTEM – A connector provided with field-wiring terminals for feed-through connection to power-limited tray cable or other appropriate cable and either a female connector to connect to a cable assembly or field-wiring terminals to connect to flexible cord.

2.7 FEED-THROUGH CONNECTOR – A male and female device directly connected through the pins or contacts. This device is not assembled on a cable or conductor.

2.8 FEMALE CABLE FITTING – A female contact device intended to be molded or assembled to flexible cord to make an electrical connection to a male cable fitting or an inlet.

2.9 GROUNDED CONDUCTOR – The circuit conductor that is intentionally grounded.

2.10 GROUNDING-CONDUCTOR PATH – A path between the grounding pin or contact and the grounding terminal.

2.11 INLET – A male contact device intended to be mounted on equipment where the conductors are internal to the equipment to provide an integral means for the connection of a female cable fitting.

2.12 INSULATION, BASIC – Insulation applied to live parts to provide basic protection against a risk of electric shock. This insulation does not necessarily include insulation used exclusively for functional purposes.

2.13 INSULATION, FUNCTIONAL – The insulation necessary for the proper functioning of the fitting and for basic protection against a risk of electric shock. This includes all parts relied upon to support live parts in place, all internal barriers necessary to maintain spacing, and the outlet face portion of all female fittings.

2.14 MALE CABLE FITTING – A male contact device intended to be molded or assembled to a flexible cord or cable to make an electrical connection to a female panel-mount fitting, a female cable fitting, or outlet.

2.15 OUTLET – A female contact device intended to be mounted on equipment where the conductors are internal to the equipment to provide an integral means for the connection of a male cable fitting.

2.16 POLARIZED DEVICE – A device constructed for connection to a mating fitting only in the position that connects related poles of an electrical circuit.

2.17 SMALL PARTS – A small part is considered to be not more than 0.122 in^3 (2 cm^3) in volume.

2.18 SPLITTER – A male fitting that terminates in two or more outlets or that terminates in two or more female cable fittings.

2.19 TERMINAL, INSULATION-DISPLACEMENT – A terminal having a contacting member that forces the conductor insulation aside and presses to contact the current-carrying conductor.

2.20 TERMINAL, PIN TYPE (INSULATION-PIERCING) – A terminal having a contact pin that punctures the conductor insulation to contact the current-carrying conductor.

2.21 TERMINAL, PRESSURE WIRE – A terminal that establishes a connection between one or more conductors and a terminal plate by means of mechanical pressure without the use of solder. The terminal is one of the following types:

a) Clamp-type – A terminal in which the conductor is held under a pressure plate or saddle clamp by one or more screws. This type of terminal may be provided in combination with a wire-binding screw terminal.

b) Setscrew-type – A terminal in which the pressure is applied by the end of the screw bearing on the conductor, either directly or through a wire-protecting pad.

2.22 TERMINAL, WIRE-BINDING SCREW – A terminal in which the conductor is bent around the screw and is clamped directly under the head of the screw when it is tightened.

2.23 TERMINAL, CRIMP TYPE – A terminal in which an electro-mechanical connection is made between the terminal lug and a conductor by compressing the lug onto the conductors.

2.24 UNIT CONTAINER – The smallest carton, package, or container, in which a fitting is packaged. A unit container may contain more than one fitting if the devices are not intended to be removed from the container for individual sale.

2.25 VALVE FITTING – A male or female fitting contact device intended to be molded or assembled to a flexible cord or cable or assembled to conduit and is intended to connected or assembled to a valve.

2.26 WRAP AROUND CORD or CABLE LABEL – An adhesive backed label that wraps around the cord or cable and adheres to the cord or cable itself or the wrap around label.

3 References

3.1 *Deleted*

3A Referenced Publications

3A.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.

3A.2 The following publications are referenced in this Standard:

ASTM D570, *Standard Test Method for Water Absorption of Plastics*

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

ASTM G152, *Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

ASTM G153, *Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

NFPA 70, *National Electrical Code*

NFPA 79, *Electrical Standard for Industrial Machinery*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 62, *Flexible Cords and Cables*

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

UL 224, *Extruded Insulating Tubing*

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

UL 248-2, *Low-Voltage Fuses – Part 2: Class C Fuses*

UL 248-3, *Low-Voltage Fuses – Part 3: Class CA and CB Fuses*

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

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

UL 248-6, *Low-Voltage Fuses – Part 6: Class H Non-Renewable Fuses*

UL 248-7, *Low-Voltage Fuses – Part 7: Class H Renewable Fuses*

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

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

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

UL 486A-486B, *Wire Connectors*

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

UL 498, *Attachment Plugs and Receptables*

UL 508, *Industrial Control Equipment*

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

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

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

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

UL 758, *Appliance Wiring Material*

UL 796, *Printed-Wiring Boards*

UL 817, *Cord Sets and Power-Supply Cords*

UL 969, *Marking and Labeling Systems*

UL 969A, *Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products*

UL 1059, *Terminal Blocks*

UL 1449, *Surge Protective Devices*

UL 1459, *Telephone Equipment*

UL 1682, *Plugs, Receptables, and Cable Connectors of the Pin and Sleeve Type*

UL 1863, *Communications-Circuit Accessories*

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

UL 2237, *Multi-Point Interconnection Power Cable Assemblies for Industrial Machinery*

UL 2238, *Cable Assemblies and Fittings for Industrial Control and Signal Distribution*

4 Components

4.1 Except as indicated in 4.2, 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 used in the products covered by this standard.

4.2 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.

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

4.4 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.

5 Units of Measurement

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

CONSTRUCTION

6 Accessibility of Uninsulated Live Parts

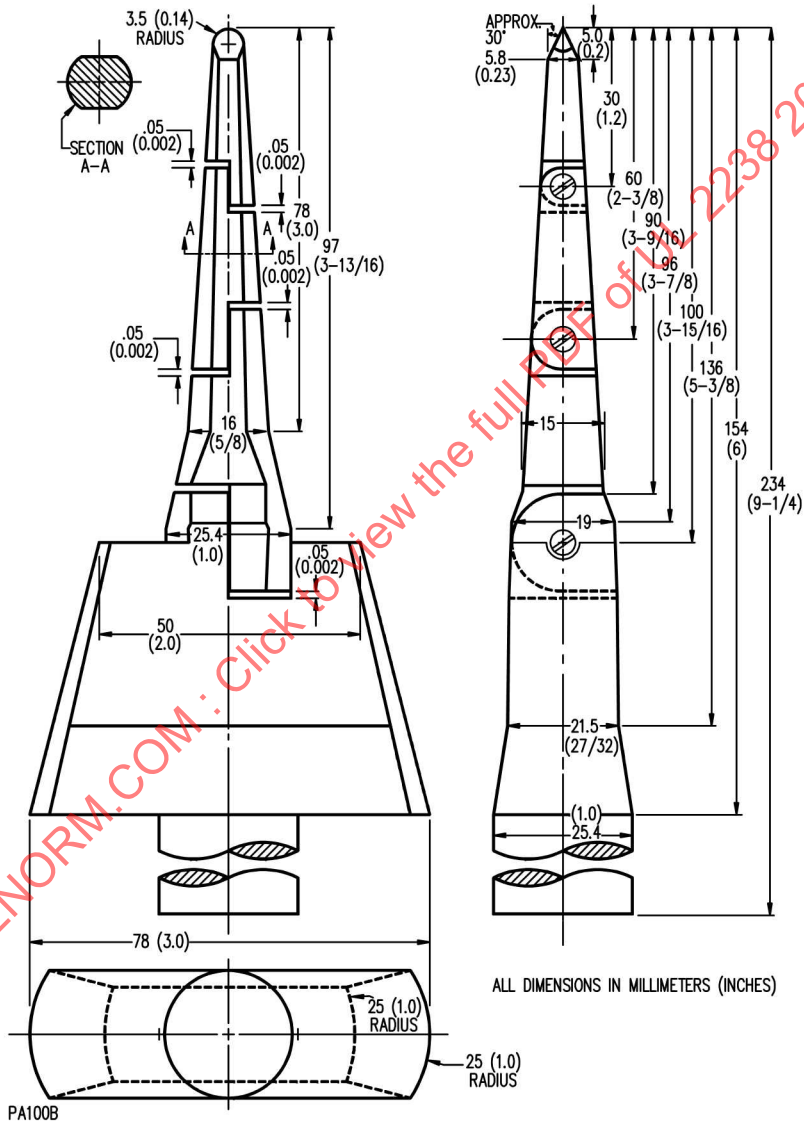
6.1 General

6.1.1 Uninsulated live parts, other than exposed wiring terminals, and internal wiring shall not be accessible to contact by the probe illustrated in Figure 6.1. The probe is to be applied with a force of 3 lbf (13.3 N). The probe is to be rotated, changed in configuration, or angled; before, during, and after application.

Exception: A device having exposed Class 2 output contacts or pins that may be contacted during normal operation or servicing need not be tested.

Figure 6.1

Accessibility probe



6.1.2 The probe is to be used as a measuring instrument to investigate the accessibility and not as an instrument to determine the strength of a material.

6.2 Valve fittings

6.2.1 Valve connectors shall comply with the requirements in 7.4, Sections 6 and 8 – 17.

6.2.2 A polymeric material used for the enclosure of a valve fitting shall have a flammability classification of 5 VA in accordance with 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 determined at the minimum thickness employed at the walls in the device which are critical to the functioning of the enclosure of the device.

Exception: A polymeric material used for the enclosure of a valve fitting is acceptable if the material is rated a minimum of HB and complies with the end product Flammability – 127 mm (5 inch) Flame Test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.2.3 A polymeric material used for electrical insulation shall comply with the requirements specified in the Standard for Polymeric Materials – Used in Electrical Equipment Evaluation, UL 746C and be suitable for direct support of live parts.

7 Insulating Materials

7.1 General

7.1.1 A part that functions as electrical insulation or as an enclosure of a device shall be made of insulating material rated for the particular application.

7.1.2 Vulcanized fiber shall not be used as the sole support of live parts. Vulcanized fiber is acceptable for insulating washers, separators, and barriers. Vulcanized fiber shall comply with Moisture Absorption Resistance Test, Section 20.

7.1.3 Tubing used to enclose live parts shall have a flammability rating of VW-1 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The tubing shall be rated for voltage and temperature for the conditions of use.

7.2 Flammability

7.2.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a flammability classification of HB, V-2, V-1, V-0, VTM-2, VTM-1, VTM-0, 5VA, or 5VB in accordance with 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 determined 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.

Exception No. 1: This requirement does not apply to a small part:

a) With a volume that does not exceed 0.122 in^3 (2 cm^3),

b) With no dimension exceeding 1.18 in (3 cm), and

c) That is located such that the part does not propagate flame from one area to another or act as a bridge between a source of ignition and other ignitable parts.

Exception No. 2: This requirement does not apply to fiber or similar material that is 0.010 in (0.25 mm) or less thick.

Exception No. 3: A material that has been subjected to the horizontal or vertical burning test (bar sample testing) as described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, need not have a flame rating.

Exception No. 4: This requirement does not apply to devices rated 8 A or less and 30 V_{rms} (42 V_{peak}) or less when marked in accordance with 40.1.12.

Exception No. 5: A polymeric material need not have a flame rating for the thinnest measured thickness when the molded material complies with the 12 mm or 20 mm (3/4 in) end-product flame tests described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.3 Electrical properties

7.3.1 General

7.3.1.1 A polymeric material used for electrical insulation or enclosure of live parts shall comply with 7.3.2, 7.3.3, and 7.3.4.

Exception No. 1: The requirements in 7.3.2, 7.3.3, and 7.3.4 do not apply to devices rated 8 A or less and 30 V (42 V_{peak}) or less.

Exception No. 2: Small parts that are made from polymeric or epoxy type materials that do not come into contact with live parts or are totally encapsulated due to their design and do not track between parts of opposite polarity and/or any other uninsulated metal parts of different polarities do not have to comply with the requirements of 7.3.2, 7.3.3, and 7.3.4. A small part is considered to be not more than 0.122 in^3 (2 cm^3) in volume.

7.3.2 Comparative tracking index (CTI)

7.3.2.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a comparative tracking index (CTI) performance level category (PLC) rating of 0, 1, 2, or 3 determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception No. 1: A polymeric material used in over-mold applications to form the enclosure of live parts or within contact with live parts not to exceed 0.039 inch (1 mm) in length shall not require a comparative tracking index (CTI) rating.

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the Comparative Tracking Index (CTI) Test in Section 35.

7.3.3 Hot wire ignition (HWI)

7.3.3.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a hot wire ignition (HWI) performance level category (PLC) rating not less than specified in Table 7.1 determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. For a material with other than a VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater. (The minimum thickness employed in the device which is critical to the functioning of the insulation of live parts.)

Exception No. 1: This requirement does not apply to:

a) A polymeric material used in an enclosure of an attachment plug or cord connector, or

b) A polymeric material that encloses insulated live parts with an insulation thickness greater than 0.025 in (0.5 mm).

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the Glow Wire Test in Section 36.

Table 7.1
Hot-wire ignition (HWI) ratings

Flammability classification[a]	HWI[b]	
	Mean ignition time[c] s	PLC[d]
V-0, VTM-0	7 and up to 15	4
V-1, VTM-1, 5VA, 5VB	15 and up to 30	3
V-2, VTM-2	30 and up to 60	2
HB	30 and up to 60	2

[a] Flammability classification – Determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

[b] HWI – Hot wire ignition (HWI) determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

[c] Mean ignition time is to be used to determine the acceptability of filament wound tubing, industrial laminates, vulcanized fiber, and similar polymeric materials only. All other materials are to be investigated using the performance level category values.

[d] PLC – performance level category.

7.3.4 High-current arc ignition (HAI)

7.3.4.1 A polymeric material used for electrical insulation of live parts shall have a high-current arc ignition (HAI) performance level category (PLC) rating not less than specified in Table 7.2 as determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. For a material with other than a 5VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater.

Exception No. 1: This requirements does not apply to:

a) A polymeric material used in over-mold applications to form the enclosure of live parts, and

b) A polymeric material used within contact with live parts not to exceed 0.039 inch (1 mm) in length.

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the High-Current Arc Resistance to Ignition Test in Section 37.

Table 7.2
High-ampere arc ignition (HAI) ratings

Flammability classification[a]	HAI[b]	
	Mean number of arcs[c] s	PLC[d]
V-0, VTM-0	15 and up to 30	3
V-1, VTM-1, 5VA, 5VB	30 and up to 60	2
V-2, VTM-2	30 and up to 60	2
HB	60 or more	1

[a] Flammability classification – Determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

[b] HAI – High-current arc ignition (HAI) determined in accordance with Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

[c] Mean number of arcs is to be used to determine the acceptability of filament wound tubing, industrial laminates, vulcanized fiber, and similar polymeric materials only. All other materials are to be investigated using the performance level category values.

[d] PLC – performance level category.

7.4 Thermal properties

7.4.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a relative thermal index (RTI) rating as specified in Table 7.3. For a material with other than a VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater.

Exception No. 1: If the polymeric material does not have a RTI value, see the Relative Thermal Indices Based Upon Past Field-Test Performance and Chemical Structure table (Table 7.1) in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, for generic RTI values.

Exception No. 2: The following generic materials having readings of 65 or less on the Shore Durometer D scale (when measured for 5 s at an ambient temperature of 23.0 ±2.0°C (73.4 ± 3.6°F)) are acceptable for use at 60°C (140°F) based on their successful completion of the appropriate accelerated aging test described in Accelerated Aging Tests, 37.5:

a) Ethylene/Propylene/Diene (EPDM);

b) Natural Rubber (NR);

c) Neoprene (Chloroprene Butadiene) Rubber (CBR);

d) Nitrile Rubber (NBR);

e) Polyvinyl Chloride (PVC) and its copolymers;

f) Styrene (Butadiene) Rubber (SBR); and

g) Thermo Elastomeric [TEE; includes Thermoplastic Elastomers (TPE) and Ethylene Propylene Thermoplastic Rubber (EPTR)].

Table 7.3
Minimum relative thermal indices (RTI)

Application	Minimum RTI[a]		
	Electrical °C (°F)	Mechanical with impact[b] °C (°F)	Mechanical without impact °C (°F)
Permanently-wired devices (cable assemblies, panel-mounted fittings, multi-outlet fittings, or feeder-tap cable systems)	50 (122)	50 (122)	50 (122)
Cable assemblies (including male cable fitting, female cable fitting, multi-outlet fittings, splitters, and feed-through connectors)	50 (122)	50 (122)	50 (122)

[a] RTI – The relative thermal index determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B or the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C.

[b] For industrial laminates, vulcanized fiber, and similar polymeric materials, the material's minimum RTI for mechanical with impact shall comply with the values specified for mechanical without impact.

8 Live Parts

8.1 Iron or steel, plated or unplated, shall not be used for a current-carrying part. Stainless steel is acceptable for a current-carrying part that is not subject to arcing.

8.2 A current-carrying part shall be restrained from turning relative to the surface on which the part is mounted if such turning affects the performance of the device.

8.3 Uninsulated live parts shall be secured in place so that the spacings are not reduced below those specified in 12.1.

9 Grounding and Dead-Metal Parts

9.1 The following grounding parts shall be copper or a copper-base alloy:

a) A grounding pin or contact, and

b) Parts that are in the grounding path in a male cable fitting, multi-outlet fitting, splitter, feed-through connector, or female cable fitting.

Exception: Fastening devices, such as coupling nuts or assemblies used to connect shielded cables, as part of the grounding path may be composed of other materials, such as zinc, so long as the interface resistance is below 25 mΩ.

9.2 Steel or its equivalent is acceptable for a rivet, bolt, or clamp that is used to secure parts in the grounding path if the rivet, bolt, or clamp is not a conductor in the grounding path.

9.3 A copper-base alloy rivet that is used to secure parts in the grounding path, or that forms a part of the grounding path, shall not contain less than 80% copper.

9.4 The requirements in 9.1 – 9.3 apply to the entire grounding-conductor path between the grounding pin or contact and the grounding terminal.

9.5 Grounding parts and dead-metal parts shall be secured in place so that the spacings are not reduced below those specified in 12.1.

9.6 A dead-metal part of a grounding device shall be conductively connected to the grounding-conductor path by means of the device unless the dead-metal part is isolated from current-carrying parts and wiring other than a complete flexible cord. A flexible cord is not complete if two insulated conductors of a parallel-type cord are split apart or where the jacket of a jacketed-type cord is removed from the insulated conductors.

9.7 A dead-metal part of a device for use in a non-grounding application where there is no provision for grounding the dead-metal part shall be insulated from live parts and wiring other than a complete flexible cord so that stray strands, malfunction of wiring terminals, or malfunction of wiring does not energize accessible dead-metal parts. A flexible cord is not complete if two insulated conductors of a parallel-type cord are split apart or where the jacket of a jacketed-type cord is removed from the insulated conductors.

9.8 For a grounding device, the pin that is to be used for grounding shall be longer than the other pins. The male cable fitting shall be constructed such that, when it is inserted into its corresponding female cable fitting, contact between the grounding pin and the corresponding grounding terminal contact will be made before contact between the other pins and their corresponding contacts.

10 Terminals

10.1 When a device is intended for connection by conductors, the means for connection shall be one of the following:

a) A wire-binding screw,

b) A factory assembled conductor attached by means of soldering, welding, riveting, or crimping, or

c) A terminal wire connector that utilizes positive screw pressure on a bared conductor or spring action type terminal.

Exception No. 1: A terminal wire connector that utilizes spring action or positive screw pressure for retaining the conductor connection may be employed provided it complies with the performance requirements in the Test Sequence for All Wiring Terminals table, Sequence 1, 2, and 3 in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E. A factory wiring terminal need not comply with the mechanical sequence, but shall comply with 10.10.

Exception No. 2: Terminal block type devices will be subjected to the requirements in the Table for Test Sequences for All Connectors, Sequence 3, in the Standard for Terminal Blocks, UL 1059. See 10.9.

10.2 A terminal wire connector that utilizes spring action for retaining the grounding terminal shall additionally comply with the Grounding (Bonding) Path Current Test specified in 37.3.

10.3 Each conductor shall be fastened to the terminals of fittings in a manner that:

a) Prevents strands of any conductor from contacting uninsulated live parts of opposite polarity or dead-metal parts,

b) Provides mechanical security in accordance with Conductor Secureness Test, Section 23,

c) Provides ampacity for compliance with Temperature Test, Section 25, and

d) Prevents strands from surfacing in a molded-on fitting.

10.4 A setscrew type terminal shall not be employed in other than a pressure wire connector as specified in 10.8.

10.5 A wire-binding screw shall thread into metal. The thickness of the metal shall provide two full threads for the screw.

Exception: A wire-binding screw that has 32 or more threads per 1 in (25.4 mm) with a terminal plate formed from stock 0.030-in (0.76-mm) thick is acceptable if the metal of the plate is extruded at the tapped hole to provide two full threads for the screw.

10.6 The minimum size for a wire-binding screw shall be as indicated in Table 10.1.

Table 10.1
Minimum sizes of wire-binding screws

Maximum terminal current A	Minimum screw size No. (metric)	Maximum number of threads per inch
15	5 (M3)	36
20	6 (M3.5)	32
30	8 (M4)	32

10.7 A direct-bearing, setscrew pressure wire connector shall comply with the applicable requirements in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

10.8 The tightening torque for a field-wiring terminal shall be specified by the device manufacturer and the device shall be marked in accordance with 40.1.8. The tightening torque shall not be less than 90% of the value required for the Static Heating Test in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, for the maximum wire size corresponding to the ampere rating of the device.

Exception: A lesser torque value meets the intent of the requirement if the connector complies with the Standard for Wire Connectors, UL 486A-486B, or the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, using the lesser torque value.

10.9 If a spring-force type terminal block is employed in a device, it shall be subjected to the requirements in the Standard for Terminal Blocks, UL 1059 (see Part III – Spring Force Connections, columns A, B, C of the Sequence of Tests for Terminal Blocks Having Spring Force Connections Table).

10.10 A terminal block having spring force connections rated for factory wiring only shall be subjected to this test in lieu of the Secureness and Pullout Test in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E. Previously unused samples of the spring force connection are to be subjected to a gradual tensile pull force. Four samples, each of the minimum and maximum rated wire size and type, are to be assembled as intended. The force to cause displacement shall be recorded.

11 Strain Relief and Cord Entries

11.1 A strain-relief means shall be provided in a device intended for connection to a flexible cord so that a pull on the flexible cord is not transmitted to the binding-screw terminals, or connection between the conductors and the pins or contacts as determined in accordance with Strain-Relief Test, Section 24.

11.2 The cord-entry hole for a flexible cord in a metal enclosure shall be provided with an insulating bushing of porcelain, phenolic, cold-molded composition, or other insulating material with equivalent properties.

11.3 Devices provided with a suitable flexible conduit adapter or threaded inlet need not comply with the requirement of 11.1.

12 Spacings

12.1 Through air and over surface spacing shall not be less than 3/64 in (1.2 mm) for a device rated 250 V or less, and not less than 1/8 in (3.2 mm) for a device rated more than 250 V:

a) Between uninsulated live parts of opposite polarity, and

b) Between an uninsulated live part and a dead-metal part that is to be grounded or that is exposed to contact by persons when the device is installed as intended.

Exception: Spacings less that those specified meet the intent of the requirement if the device complies with the Dielectric Voltage-Withstand Test, Section 21.

12.2 With reference to 12.1(b), dead metal includes a metal surface on which the device is mounted. A dead-metal screwhead, rivet, or a similar part is not exposed to contact by persons where, after the device is installed in the intended manner, the dead metal is located in a hole not larger than 9/32 inch (7.1 mm) in diameter and recessed not less than 3/16 inch (4.8 mm) in the clear.

13 Assembly

13.1 General

13.1.1 An assembled-on or panel-mounted device shall be easily wired as intended so that the wires are not damaged.

13.1.2 Electrical contact shall be reliably maintained at any point at which a connection is made between current-carrying parts.

13.1.3 A live part of an outlet or cord-connected device shall be protected against exposure to contact by persons when the device is assembled and installed as intended.

13.1.4 Where internal connections exist in a multi-outlet device, similar and corresponding contacts of individual outlets shall be connected together.

13.1.5 A device having female contacts shall be constructed so that a mating male cable fitting seats without exposure of the contacts of the male cable fitting between the plane of the face of the male cable fitting and the plane of the rim of the female cable fitting device.

13.1.6 The insulation and braid on the individual conductors of a cord shall be removed only to the extent required to make the proper wire connection.

13.1.7 A device shall have a conductor attached to each terminal in each fitting and a terminal in each fitting for each conductor.

Exception: Dummy terminals may be provided if the correct assembly/installation of the terminals is specified in the installation instructions. In addition, the construction of the dummy terminals (and contacts) shall be such so that it is not possible to wire to them from the inside.

13.1.8 Each device shall employ materials throughout that are acceptable for the particular use, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

13.2 Polarization

13.2.1 A device shall be constructed so that the grounding member of the corresponding male cable fitting or female cable fitting or is not able to be inserted by hand into any outlet or inlet slot respectively to touch a live contact.

13.2.2 A device consisting of two or more pieces shall be such that any foreseeable assembly during installation does not defeat polarization.

13.3 Mating and interchangeability

13.3.1 A device shall be constructed so that electrical continuity between respective and similarly marked terminals is established automatically when the mating male cable fitting and outlet device are connected together.

13.3.2 An outlet shall not accommodate an male cable fitting other than one that is specifically intended for use with the outlet.

Exception: This requirement does not apply to 5-pole outlets having a single keyway that accommodate 4-pole male cable fitting having a single key.

13.4 Fittings

13.4.1 A fitting that is molded to or assembled to conduit shall comply with the Standard for Fittings for Cable and Conduit, UL 514B.

13.5 Identification and wiring

13.5.1 A terminal of a cable assembly, which is identified for the connection of either a grounded conductor or a grounding conductor, shall be connected to the corresponding identified conductor of the cord.

13.5.2 An assembled-on terminal of a cable fitting or panel-mount fitting intended as a grounded conductor or a grounding conductor shall be identified in accordance with Table 13.1. No other terminals shall be so identified.

Table 13.1
Identification of wiring terminals

Identification	Grounded terminal	Grounding terminal
Wire-binding screw	White metal or plating on circular screw head	Hexagonal, green-colored nut or slotted screw head where screw is not readily removable
Pressure wire terminal, visible	White metal or plating on terminal	Green colored terminal, screw or appendage that is not readily removable
Terminal, concealed	Distinct white-colored area adjacent to wire entrance hole or the word "White" or letter "W" distinctively marked adjacent to wire entrance hole	Distinct green-colored area adjacent to wire entrance hole or the word "Green" or "Ground" distinctively marked adjacent to wire entrance hole, or the letters "G," "GR," or "GND", or the grounding symbol shown in Figure 13.1 distinctively marked

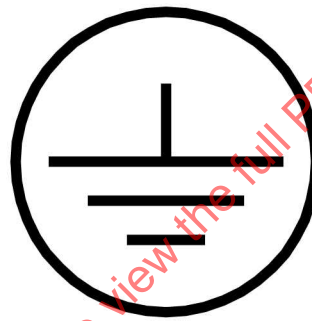
Table 13.1 Continued on Next Page

Table 13.1 Continued

Identification	Grounded terminal	Grounding terminal
		adjacent to wire entrance hole in letters not less than 1/16 in (1.6 mm) high
Terminal plate (where all terminal screws are the same color)	White metal or plating	–
Insulating enclosure or terminal	The word "White" marked on or directly adjacent to terminal, or white metal or plating on terminal	The word "Green" marked on or directly adjacent to terminal, or green-colored terminal

Figure 13.1

Grounding symbol



13.5.3 A wire lead of an assembled-on device intended for field wiring shall be:

a) Grounding conductor – Green with or without one or more yellow stripes;

b) Grounded conductor – solid white or gray or striped with white or gray.

c) All other conductors – Any color, with or without one or more stripes, except green with or without one or more yellow stripes.

Exception: This requirement does not apply to devices rated 8 A or less and 30 V_{rms} (42 V_{peak}) or less when marked in accordance in 40.1.12.

14 Enclosure

14.1 A cable fitting wired on flexible cord and assembled as intended, using only those parts required for the operation of the device, shall have the wire terminations completely enclosed.

14.2 With reference to 14.1, a part is required for the operation of the device where it:

a) Encloses or completes the enclosure of current-carrying parts other than those on the face of the male cable fitting, or

b) Encloses or completes the enclosure of the flexible cord from which the jacket has been removed for wiring.

14.3 With reference to 14.1, a part that performs no function other than to provide strain relief is not required for the operation of the device.

15 Cable Assemblies

15.1 General

15.1.1 A cable assembly shall comply with Sections 7 – 14.

15.1.2 Corresponding terminals of line and load fittings shall be connected to the same conductor of the cable.

15.1.3 The line and load fittings of a cable assembly shall have identical electrical ratings. If the line fitting of an assembly is a grounding configuration than the load fitting shall also be of a grounding configuration. If the load fitting of an assembly is a grounding configuration than the line fitting shall also be of a grounding configuration.

15.1.4 For a cable assembly employing shielded cord, the shield or drain wire shall be bonded, along with the grounding conductor, to the grounding contact of both the male cable fitting and the female cable fitting.

15.2 Flexible cord or cable

15.2.1 A flexible cord or cable shall be rated for the conditions of use and shall have electrical ratings not less than the female cable fitting or male cable fitting assembled on the cord.

16 Mounting

16.1 A panel-mounted device shall be provided with means for permanent mounting.

17 Outdoor Use

17.1 The flexible cord or conduit of a device intended for outdoor use shall be rated for outdoor use and shall be marked in accordance with 40.1.10 and 40.1.11.

17.2 A fitting of a device intended for outdoor use shall be resistant to sunlight, mechanical abuse, and moisture.

17.3 A fitting of a flexible cord shall exclude moisture by adhering tightly to the jacket of the cord at the point where the jacket of the cord enters the fitting as determined in accordance with Adhesion Test, Section 29.

17.4 A device for outdoor use shall have an outdoor environmental type enclosure rating in accordance with the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E and shall comply with Environmental Enclosure Tests, Section 30.

17.5 A Type 4 or 4X enclosure intended for Indoor Use Only and marked in accordance with 40.1.10A:

a) Need not be subjected to the External Icing Test in the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E; and

b) For a polymeric enclosure, need not have a material which is resistant to ultraviolet light weathering in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C.

PERFORMANCE

18 General

18.1 Unless stated otherwise, three representative devices are to be used for each test.

Exception: Only one sample is required to be tested if the enclosure is completely made of metal for junction boxes.

18.2 Refer to Table 18.1 for sample requirements for each test.

Table 18.1
Summary of tests

Section	Test	Number of Devices	Details
19	Mold Stress-Relief Distortion Test	3	–
20	Moisture Absorption Test	3	Only applies to devices employing vulcanized fiber
21	Dielectric Voltage-Withstand Test	3	–
22	Insulation Resistance Test	1	Conducted on devices employing rubber or similar materials that contain enough free carbon to render the material grey or black in color
23	Conductor Secureness Test	3	Crimped connections only
24	Strain-Relief – A. Cord to Fitting Test B. Feeder-Tap Cable Systems Test	6	
24A	Overload test	3	Devices intended for current interruption under load conditions.
25	Temperature Test	3	Mated pairs. For devices intended for current interruption under load conditions same 3 previous subjected to Overload testing as used.
25A	Resistance to Arcing	Same 3	For devices intended for current interruption under load conditions are used.
26	Current- Cycling and Vibration Test	6	Mated pairs
27	Jacket Retention Test	3	Molded-on devices
28	Polarization Test	1	–
29	Adhesion Test	1	
30	Environmental Enclosure	–	See the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E for that type rating.
31	Grounding Impedance Test	1	Mated pair
32	Fault Current Test	2	Mated pairs
33	Cable Pullout Test (For Pin Type or Insulation Displacement Type Terminals)	6	Assembled-on devices Additional samples may be necessary based upon maximum AWG size conductor
33	Creep Test (For Pin Type or Insulation Displacement Type Terminals)	3	Assembled-on devices Additional samples may be necessary based upon size and type of cable

Table 18.1 Continued on Next Page

Table 18.1 Continued

Section	Test	Number of Devices	Details
35	Comparative Tracking Index Test	3	Material to be evaluated in accordance with Exception No. 2 of 7.3.2.1
36	Glow Wire Test	3	Material to be evaluated in accordance with Exception No. 2 of 7.3.3.1
37	High-Current Arc Resistance to Ignition Test	3	Material to be evaluated in accordance with Exception No. 2 of 7.3.4.1
37.2	Strength of Insulation Base Test	6	Device employing pressure-wire terminals for field connection.
37.3	Grounding (Bonding) Path Current Test	1	Mated pair
37.4	Assembly Test	6	Assembled-on devices Additional samples may be necessary based upon size and type of cable
37.5.1	Accelerated Aging (Rubber, EPDM, or TEE compound) Test	6	–
37.6	Accelerated Aging (PVC compounds and copolymers) Test	6	–
37.7	Crushing Test (Valve connectors only)	6	Valve connectors only
37.8	Impact Test (Valve Connectors Only)	6	Valve connectors only
37.9	Low Temperature Test (Valve Connectors Only)	6	–
37.10	Permanence of Flag Type cord or cable tag Test	6	Samples with flag or cord tag label
37.11	Permanence of Wrap Around Cord or Cable Label Test	6	Samples with label

19 Mold Stress-Relief Distortion Test

19.1 As a result of the conditioning specified in 19.2, nonmetallic parts of a device shall not warp, shrink, or distort to the extent that results in any of the following:

a) Making uninsulated live parts, other than exposed wiring terminals, or internal wiring accessible to contact as determined in accordance with Accessibility of Uninsulated Live Parts, Section 6.

b) Defeating the integrity of the enclosure so that 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 male cable fitting of the intended configuration.

d) A condition that results in the device not complying with Strain-Relief Test, Section 24.

e) A reduction of spacings below the spacings specified in Spacings, Section 12.

f) A condition that results in the device not complying with Dielectric Voltage-Withstand Test, Section 21.

g) Any other evidence of damage that results in a risk of fire or electric shock.

Exception: A device employing only thermosetting materials is not required to be subjected to this test.

19.2 The devices are to be placed in a full-draft circulating-air oven for 7 h at the highest temperature to which the nonmetallic part is exposed as determined in accordance with Temperature Test, Section 25,

plus 10°C (18°F) but not less than 70°C ±1°C (158°F ±1.8°F). The devices are to be removed from the oven and cooled to room temperature before determining compliance. See 19.3.

19.3 During the examination of a product to determine compliance with 19.1:

a) The device is to be wired and assembled in accordance with the manufacturer's instructions,

b) A part, other than a required part described in 14.2 and 14.3, that can be opened or removed by the user without using a tool is to be opened or removed.

20 Moisture Absorption Resistance Test

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

20.2 The material is to be:

a) Dried at 105 ±5°C (221.0 ±9.0°F) for 1 h;

b) Weighed, (W_1);

c) Immersed in distilled water at 23 ±1°C (73.4 ±1.8°F) for 24 h;

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

e) Reweighed, (W_2).

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

$$\frac{W_3 - W_1}{W_1} \times 100\%$$

Exception: A material tested in accordance with the Standard Test Method for Water Absorption of Plastics, ASTM D570 described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, is not required to be tested.

21 Dielectric Voltage-Withstand Test

21.1 A device shall withstand without breakdown a 50 – 60 Hz sinusoidal potential applied as described in 21.2 and 21.3 for one minute between live parts, between live parts of opposite polarity, and between live parts and grounding or dead-metal parts.

21.2 A feeder-tap cable system shall be capable of withstanding the application of an ac or dc potential of 2000 V for a device rated 300 V or less, and 3000 V for a device rated more than 300 V. All other devices shall be capable of withstanding the application of an ac potential of 1000 V plus 2 times the rated voltage.

Exception No. 1: A test potential of 500 V is to be applied to a device rated 30 V_{rms} (42.4 V_{peak}) or less.

Exception No. 2: The equivalent dc potential may be substituted if necessary due to components employed in the circuitry.

21.3 The device is to be tested by means of a 500 VA or larger capacity transformer whose output voltage is sinusoidal and variable. The applied potential is to be increased from zero until the required test

level is reached, and is to be held at that level for one minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

Exception: When the output of the test-equipment transformer is less than 500 VA, the equipment is to include a voltmeter in the output circuit to indicate the test potential directly.

22 Insulation Resistance Test

22.1 As a result of the test described in 22.2 – 22.5, the insulation resistance of a fitting shall not be less than 100 MΩ between:

a) Live parts of opposite polarity,

b) Live parts and dead-metal parts that are exposed to contact by persons or that may be grounded in service, and

c) Live parts and any surface of insulating material that is exposed to contact by persons or that may be in contact with ground in service.

22.2 One sample is to be used for this test. The insulation resistance measurement is to be made on rubber and polymeric materials of any color that may contain carbon (usually black and gray).

22.3 All parts are to be maintained at room temperature for not less than 48 h before being subjected to the test.

22.4 A quantity of No. 7 lead drop shot, diameter 0.10 in (2.5 mm), is to be placed in a container that is open at the top. After cord entry holes or other openings through which the shot is able to enter have been carefully plugged with a high-resistance insulating material, the fitting is to be immersed in the shot so that the shot serves as an electrode in contact with the surface to which the test is to be applied.

Exception: If lead shot is not available, metal foil is to be formed onto each device. The foil is to be tightly wrapped on surfaces other than the fitting face.

22.5 The insulation resistance is to be measured by a magnetomefohmeter which has an open-circuit output of 500 V or by equivalent equipment.

23 Conductor Secureness Test

23.1 Where a conductor of a flexible cord or cable is connected to a contact of a device before the contact has been assembled into the device, the connection before the contact has been assembled into the device shall not break as a result of a pull applied for 1 min between the contact and the conductor. A force as specified in Table 23.1 is to be applied. The angle between the contact and the conductor is to be that used in the completely assembled device. The force is to be applied gradually.

Exception: This is not applicable to insulation displacement terminals.

Table 23.1
Conductor secureness test values

Wire size AWG (mm^2)	Pull force lbf (N)
30 (0.05)	1 (4.4)
28 (0.08)	2 (8.9)
26 (0.14)	4 (17.8)
24 (0.21)	6 (26.7)
22 (0.34)	8 (35.6)
20 (0.52)	10 (44.5)
18 (0.82) or larger	20 (89)

24 Strain-Relief Test

24.1 Cord-to-fitting test

24.1.1 The assembly or molding of a cord to a fitting shall be subjected to a straight pull force as specified in 24.1.2 and Table 24.1 applied between the fitting and the cord. As a result of the test, the force shall not be transmitted to the terminals of the fitting.

Table 24.1
Strain-relief test values

Type of device	Wire size AWG (mm^2)	Pull force lbf (N)
Cord-to-fitting	30 (0.05	1 (4.4)
	28 0.08)	2 (8.9)
	26 (0.14)	4 (17.8)
	24 (0.21)	6 (26.7)
	22 (0.34)	8 (35.6)
	20 (0.52)	10 (44.5)
	18 (0.82) or larger	30 (133)

24.1.2 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 as specified in Table 24.1 is to be applied by means of a weight for 1 min to the flexible cord, in a direction perpendicular to the plane of the cord-entry hole.

24.2 Feeder-tap cable systems test

24.2.1 With the device supported securely, a weight as specified in Table 24.2 is to be suspended on a cord having conductors the size specified in Table 24.2. The weight is to be suspended for 1 min in a direction perpendicular to the plane of the cord entry hole of the device.

Table 24.2
Strain-relief test values for feeder-tap cable systems

Type of device	Wire size AWG (mm^2)	Pull force lbf (N)
Feeder-Tap Cable System	18 (0.82)	35 (156)
	16 (1.3)	35 (156)
	14 (2.1)	50 (222)
	12 (3.3)	50 (222)
	10 (5.3) or larger	100 (445)

24A Overload Test

24A.1 A female device shall perform acceptably when subjected to an overload test as described in 24A.3 – 24A.11. There shall not be any electrical or mechanical failure of the device nor pitting or burning of the contacts that would affect the intended function. The grounding fuse shall not open during the test.

24A.2 A device that is intended not for current interruption and is marked in accordance with 40.1.6 need not be subjected to this test.

24A.3 A mating device is to be inserted and withdrawn either manually or by machine while connected to a suitable load. The equipment grounding contact is to be connected to ground through a fuse.

24A.4 For ac applications intended for across-the-line ac motor starting, single, 2- and 3- phase, the test current shall be 6 times device full-load current with a power factor of 0.4 – 0.5.

24A.4A For ac applications intended for ac general use, the test current shall be 1.5 times the marked ampere rating at the marked voltage, with a power factor of 0.75 – 0.80. Devices shall additionally be marked as describe in 40.1.6, Exception No. 2.

24A.5 For dc applications intended for across-the-line dc motor starting the test current shall be 10 times device full-load current with a non-inductive resistive load.

24A.5A For dc applications intended for dc general use, the test current shall be 1.5 times the marked ampere rating at the marked voltage, with a non-inductive resistive load. Devices shall additionally be marked as describe in 40.1.6, Exception No. 3.

24A.6 The full load current (FLA) shall be based upon the device voltage rating and Hp rating assigned by the manufacturer. See the Standard for Industrial Control Equipment, UL 508, the Full-load Motor-running Currents in Amperes Corresponding to Various a-c Horsepower Ratings Table and the Full-load Motor-running Currents in Amperes Corresponding to Various d-c Horsepower Ratings Table for details.

24A.7 The potential of the test circuit closed voltage is to be from 100 – 110% of the rating of the device in volts.

24A.8 Each device shall be subjected to 50 cycles of operation at a rate not higher than 10 cycles/min. The device is to be rigidly supported. For devices that employ multiple circuits, all circuits at their given ampacity are to be tested simultaneously. Exposed metal parts and any pole that is not part of the test circuit are to be connected through a fuse to ground of the test circuit.

24A.9 The fuses in the test circuit shall be non-time-delay, general use, cartridge type fuses. The fuse in the grounding (bonding) conductor circuit shall have a 15-A rating if the device under test is rated at 30 A

or less. If the device under test is rated at more than 30 A the grounding fuse shall have a rating of 30 A. For the line fuse, the next higher commercial fuse rating than the value of the test current in the test circuit shall be used.

24A.10 A previously untested male contact device is to be used for each overload test.

Exception: One device may be used for all of the overload tests if agreeable to all concerned.

24A.11 Contacts of the device are not to be adjusted, lubricated, or otherwise conditioned before or during the test.

24A.12 After this test, the device shall be subjected to the Dielectric Voltage-Withstand Test in Section 21.

25 Temperature Test

25.1 A device tested as described in 25.2 – 25.5 shall not attain a temperature at any point sufficiently high:

a) To constitute a risk of fire,

b) To adversely affect any material employed in the device,

c) To exceed a temperature rise more than 30°C (54°F), or

Exception: A temperature rise on an insulating material greater than 30°C (54°F) is acceptable if the temperature does not exceed the Relative Thermal Index (mechanical with impact) of the insulating material when the device is carrying maximum rated current.

d) To exceed the thermal rating of a flexible cord.

e) For devices intended for current interruption, to exceed a temperature rise more than 30°C when the device is carrying its maximum rated current. This temperature rise is based on devices intended to be wired with conductors rated 60°C. A temperature rise of 45°C shall be permitted when the device is intended to be wired with conductors rated 75°C or higher, and so marked. See 40.1.6.

25.1.1 The temperature test shall be performed following the overload test, if applicable, on the same test samples.

25.2 Each current-carrying conductor of the device is to be caused to carry continuously a current equal to the current rating of the device or tap.

25.3 For wiring terminals, the temperature measurement is to be made on the wiring terminal where the terminal is accessible for the mounting of thermocouples. If the wiring terminal is inaccessible or the device has no wiring terminals, temperatures are to be measured at points as close to the face of the device as possible on the male pins of an male cable fitting inserted into the mating female cable fitting.

25.4 The temperature test is to continue for 4 h even when stabilized temperatures are attained in a shorter interval of time. The generation of heat from sources, other than the female contacts is to be minimized as much as practicable. For example, each connection to the device is to be made by means of a 6-in (150-mm) or shorter length of wire. The contacts of the device are to be connected together by means of an male cable fitting inserted therein. The male cable fitting is to have the same configuration as the device under test. The male cable fitting is to be factory wired or wired as specified by the manufacturer. The leads of the male cable fitting are to be short-circuited by means of 6-in (150-mm)

lengths of wires as previously described. For assembled-on devices, the terminals are to be tightened to the marked torque limit.

25.5 Temperature readings are to be obtained by means of thermocouples. Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). Whenever referee temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument are to be used. The thermocouple wire is to conform with the requirements for Special Tolerances as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

25.7 After this test, devices intended for current interruption under load conditions shall be subjected to the Dielectric Voltage Withstand Test in Section 21.

25A Resistance to Arcing Test

25A.1 The same samples previously subjected to overload, temperature, dielectric voltage withstand testing shall be subjected to an additional 200 cycles of operation under the overload test conditions.

25A.2 The mating device (plug portion) used for this test may be changed after every 50 operations. There shall not be any sustained flaming of the material in excess of five seconds duration. There shall not be any electrical tracking or the formation of a permanent carbon conductive path which results in a dielectric breakdown, as determined by the Dielectric Voltage-Withstand Test, Section 21, applied for one minute between live parts of opposite polarity and between live parts and dead metal parts.

26 Current-Cycling and Vibration Test

26.1 General

26.1.1 Following the Current-Cycling and Vibration Tests described in this section, each device having pin-type (insulation-piercing) or insulation displacement terminals shall comply with the thermal stability criteria specified in 26.1.2.

26.1.2 As a result of current cycling before and after vibration conditioning as described in 26.2, 26.3, and 26.4, a device employing pin-type (insulation-piercing) or insulation-displacement terminals on the fitting terminals shall comply with the following:

a) The thermal stability shall be such that none of the 11 data points deviate above the average temperature by more than 10°C (18°F) as determined in accordance with 26.5.1,

b) There shall not be a temperature rise of more than 100°C (180°F), and

c) There shall not be a temperature rise greater than 100°C (180°F) on any feeder-tap cable system.

26.1.3 Following the manufacturer's instructions, three of the six representative devices are to be assembled on the wire of the size and type specified by the manufacturer. Solid copper wire is to be used unless otherwise specified in the instructions.

26.1.4 The devices are to be connected with 24 to 27 in (610 to 666 mm) of cable between each device and wired in series so that the test current passes through the connection point of the entering conductor, the internal structure of the device, and the exiting conductor.

26.1.5 Three of the six devices are to be mounted to a test rack constructed of any rigid material (i.e., cast-iron, steel, or aluminum) which neither absorbs nor creates any variation of the applied frequency waveform, forming a rigid assembly. Mounting holes are to be provided for attachment of the test rack to a vibration platform.

26.2 Current-cycling before vibration test

26.2.1 Each current cycle is to consist of 1-1/2 h "on" time and 1/2 h "off" time with a total of 500 cycles on each device. The test current is to be 200% of the current rating of the device.

26.2.2 Temperature rises are to be measured using thermocouples placed on the pins of the male fitting, as close as possible to the face of the fitting.

26.2.3 Temperature readings are to be obtained by means of thermocouples described in 25.5.

26.2.4 The temperature of the connection is to be recorded at 25, 50, 75, 100, 125, 175, 225, 275, 425, and 500 cycles.

26.3 Vibration test

26.3.1 Following 125 cycles of current cycling as described in 26.2.1 – 26.2.4, the three devices mounted to the test rack are to be disconnected from the circuit and subjected to vibration testing as described in 26.3.2.

26.3.2 The test rack is to be fastened to a vibration platform and subjected to the following conditioning;

a) Simple harmonic motion of amplitude 0.03 in (0.76 mm), 0.06 in (1.52 mm) peak-to-peak, with the frequency varied uniformly in one minute from 10 cps to 55 cps and back to 10 cps.

b) Vibration applied for 2 h in each of three mutually perpendicular directions for a total of 6 h of testing.

26.3.3 At the conclusion of the vibration, each device is to be reconnected to the current cycling test circuit to complete the 375 remaining cycles of the Current Cycling Test, as described in 26.4.1, for a total of 500 cycles.

26.4 Current-cycling after vibration test

26.4.1 After vibration, six additional data points for each device are to be obtained at 170, 215, 260, 340, 420, and 500 cycles of current cycling. The test method is to be as specified in 26.2.1 – 26.2.3.

26.5 Calculations

26.5.1 The thermal stability for each thermocouple location is to be determined as follows:

a) Determine the average temperature rise for all 11 data points obtained in accordance with 26.2.4 and 26.4.1, and

b) Determine the deviation of each of the 11 data points from the calculated average.

27 Jacket Retention Test

27.1 For devices molded onto jacketed cord, employing either 18 AWG (0.824 mm^2), 17 AWG (1.04 mm^2), 16 AWG (1.31 mm^2), 15 AWG (1.65 mm^2) or 14 AWG (2.08 mm^2) conductors, there shall not be

fillers, separators, insulation, or bare conductors visible at the point where the cord enters the fitting as a result of the test described in 27.2 – 27.5. A male cable fitting or female cable fitting of a cable assembly shall retain the jacket of the flexible cord to which it is molded.

27.2 Six previously untested samples, with 12 in (305 mm) of flexible cord attached, are to be used for this test. The cord jacket of each of the samples is to be slit for a short distance at a point 6 in (152 mm) from the point of cord entry to the fitting. All internal conductors, conductor insulation, fillers, and separators are to be severed.

27.3 Samples are then to be secured by the body of the fitting so that the flexible cord jacket is hanging vertically. A pull of 15 lbf (67 N) is to be applied for 2 min at a point 8 in (203 mm) from where the cord enters the fitting.

27.4 Each molded-on fitting is then to be connected by the body to a test apparatus having a vertical assembly capable of rotating through 360° and securing the fitting so that the cord exits the fitting being tested with the longitudinal axis of the cord in a horizontal direction, perpendicular to the plate face.

27.5 A weight of 3 lb (1.4 kg) is to be suspended at a point 8 in (203 mm) from where the cord enters the fitting for 15 s. With the weight still attached, the test apparatus mounting plate then is to be rotated 360° about the horizontal axis of the cord exit (from the fitting) in 15 s, during which time the cord-body interface is to be visually examined to determine compliance with 27.1.

28 Polarization Test

28.1 Compliance with 13.3.2 is to be determined by using one sample of the device assembled in its intended housing. With the axis of the mating devices aligned, the devices shall not be able to mate in any manner that energizes the grounding feature of the device. The polarization of the device shall not be defeated.

29 Adhesion Test

29.1 To determine compliance with 17.3, one sample is to be evaluated. The adhesion between a cord and the body of a fitting, the cord is to be bent sharply to an angle of 90° with the plane of the cord entry and visually examined for openings into the body.

29.2 If from the visual examination specified in 29.1 there is reason to suspect that an acceptable seal does not exist, the assembly is to be cut apart for examination. The adhesion is acceptable if the examination of the inner construction reveals a positive seal at all points around the periphery of the cord.

30 Environmental Enclosure Tests

30.1 A device for outdoor use shall have an outdoor environmental type enclosure rating and shall comply with the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E for that type rating.

30.2 When a panel-mounted device is tested, it is to be mounted in accordance with the manufacturer's instructions on a panel of the appropriate enclosure type.

31 Grounding Impedance Test

31.1 For a device without a power-supply cord when tested in accordance with 31.3 and 31.4, the impedance at 60 Hz between the grounding terminal and any accessible grounded metal part shall not

exceed 0.1 Ω. For a device with an inlet, the impedance between the grounding pin in the inlet and any grounded accessible metal shall not exceed 0.1 Ω.

31.2 For a device that is assembled or molded on to the cord, the impedance at 60 Hz between the grounding pin of the male cable fitting and any other metal part of the device that is required to be grounded shall not be more than 0.2 Ω when measured in accordance with 31.3 and 31.4.

31.3 A current of 40 A derived from a 60-Hz source with a no-load voltage not exceeding 6 V is to be passed for 2 min through the grounding terminal or the grounding contact in the appliance inlet or the grounding pin in the male cable fitting and each accessible grounded metal part which could become live in case of failure in basic insulation.

31.4 The voltage drop between the parts is to be measured and the impedance determined from the current and voltage drop.

32 Fault Current Test

32.1 When a feeder tap cable system that uses a printed wiring board as part of the grounding path is tested as described in 32.2, the circuit breaker shall operate when the test circuit is closed. The grounding path shall retain its integrity as demonstrated by a continuity check after removing and reinserting the mating female cable fitting. There shall not be ignition of the cotton or cord insulation.

32.2 Two samples are to be tested on a circuit capable of delivering 1000 A at rated voltage through shorted bus bars. Two of the feeder tap cable system terminals of each sample (one of which is the equipment grounding terminal when one is provided) are to be wired to the test terminals using a total of 4 ft (1.22 m) of the largest size wire with which the feeder tap cable system is intended to be used. A thermal-type circuit breaker rated equivalent to the branch circuit protection is to be connected between the line terminal and one test terminal. A 2-ft (610-mm) length of flexible cord is to be connected to the tap terminals of the sample that are associated with the two feeder tap terminals. The bared ends of the two conductors of the flexible cord are to be twisted and soldered together. The feeder tap terminal is to be surrounded with absorbent cotton. The short-circuit is to be introduced to the circuit by closing an external switching device.

33 Cable Pullout Test (For Pin Type or Insulation Displacement Type Terminals)

33.1 As a result of the test in 33.2, there shall not be:

a) Visible indication of conductor pullout,

b) Damage to the cable insulation, or

c) Loosening of the assembly that enables the cable to be removed by flexing or bending following the removal of the test force.

33.2 Six devices that are provided with assembled on cable are to be installed on each size and type of cable with which the device is intended to be used. The cable installation is to be in accordance with the manufacturer's instructions. Wiring terminals having a screw-actuated clamping means are to be tightened to the manufacturer's specified torque and then loosened one full turn before application of the test force. Each cable is then to be subjected to a pull force of 60 lbf (267 N) applied perpendicular to the plane of the cable entrance (along the wire) for five minutes. The devices are to be rigidly supported during testing in such a manner that movement of the cable is not restricted.

34 Creep Test (For Pin Type or Insulation Displacement Type Terminals)

34.1 A cable assembly device shall comply with Cable Pullout Test, Section 33, following the oven conditioning described in 34.2.

Exception: This test does not apply to devices employing only thermosetting materials.

34.2 The devices are to be assembled as intended on each type of cable of the maximum AWG size conductor intended for use. Three samples are to be assembled midway on the cable and three are to be assembled onto the end of the cable. Each device is then to be conditioned in an air-circulating oven for 300 h at 90°C (194°F).

35 Comparative Tracking Index Test

35.1 A polymeric material used for electrical insulation or enclosure of live parts, evaluated in accordance with Exception No. 2 to 7.3.2.1 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.

36 Glow Wire Test

36.1 A polymeric material used for electrical insulation or enclosure of live parts and evaluated in accordance with Exception No. 2 of 7.3.3.1, shall be tested in accordance with the requirements of 36.2 in order to determine its resistance to ignition from overheated conductors caused by circuit overloads.

36.2 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 s of application of the probe at a glow-wire temperature of 650°C (1202°F) for all devices.

37 High-Current Arc Resistance to Ignition Test

37.1 General

37.1.1 A polymeric material used for electrical insulation or enclosure of live parts and evaluated in accordance with Exception No. 2 to 7.3.4.1, when tested as described in 37.1.2 – 37.1.6, shall not ignite within the number of arcs specified in Table 37.1 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.

Table 37.1
High-ampere arc ignition (HAI) ratings

Flame class	Number of arcs
HB	60
V-2, VTM-2	30
V-1, VTM-1, 5VA, 5VB	30
V-0, VTM-0	15

37.1.2 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 in (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 in (0.8 mm) but less than 1/2 in (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.

37.1.3 The test circuit is to provide test currents and test voltages equal to the current and voltage ratings of the device to be tested. 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 in (1.2 mm) for a device rated 250 V or less and 1/8 in (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.

37.1.4 Immediately following the completion of the arcing portion of the test, the device is to be subjected to a 50 to 60 Hz essentially sinusoidal potential applied as described in 37.1.5 between live parts of opposite polarity and between live parts and dead metal parts. The test potential is to equal twice the rated voltage of the device plus 1000 V.

37.1.5 The device is to be tested by means of a 500 VA or larger capacity transformer whose output voltage is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached, and is to be held at that level for one minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

37.1.6 If the output of the test equipment transformer is less than 500 VA, the equipment is to include a voltmeter in the output circuit to indicate the test potential directly.

37.2 Strength of insulation base test

37.2.1 A device employing pressure-wire terminals for field connection, shall not be damaged when 110% of the specified terminal tightening torque is applied to the wire securing means of the pressure-wire terminal which secures the maximum intended size conductor.

37.2.2 Damage is considered to have occurred if any cracking, bending, breakage, or displacement of the insulating base, current-carrying parts, assembly parts, or device enclosure reduces electrical spacings to less than those required, exposes live parts, or otherwise impairs the intended secure installation and use of the device.

37.2.3 The terminal tightening torque to be used for this test is to be that assigned by the manufacturer in accordance with 10.8 and marked in accordance with 40.1.8.

37.3 Grounding (bonding) path current test

37.3.1 The assembly of mating grounding devices shall carry the current specified in Table 37.2 for the time specified in that table. The current shall be based on the minimum size equipment grounding

conductor required for the ampere rating of the device. See Table 37.2. The components in the grounding path shall not crack, break, or melt.

Table 37.2
Short time current test

Device rating A	Minimum size equipment grounding (bonding) conductor (copper) AWG (mm^2)	Time s	Test current A
0 – 6	18 (0.82)	4	120
6.1 – 10	16 (1.3)	4	190
10.1 – 15	14 (2.1)	4	300
15.1 – 20	12 (3.3)	4	470
20.1 – 30	10 (5.3)	4	750
30.1 – 50	8 (8.4)	4	1180
50.1 – 60	6 (13.3)	6	1530

37.3.2 The mating devices shall be mounted and assembled as intended. A grounding conductor of the appropriate size, not less than 2-ft (0.6-m) long, shall be connected to the grounding terminal of each device. If the device is provided with field wiring terminals, the conductor shall be tightened using a torque as specified by the manufacturer's instructions. Receptacles and power inlets shall be wired with the minimum allowable size copper building wire conductor. Plugs and connectors shall be wired with flexible, stranded conductor from flexible cord or cable sized on the basis of the ampere rating of the device. The test current shall be passed through the mating devices and grounding wires in series.

37.3.3 After having carried the current specified in 37.3.1, continuity shall exist on the test assembly when measured between the grounding (bonding) conductors.

37.3.4 Any indicating device such as an ohmmeter, battery-and-buzzer combination, or the like, may be used to determine whether continuity exists.

37.4 Assembly test

37.4.1 A device that is intended for field installation shall be able to be readily assembled to the flexible cords or cables that is intended to be used.

37.4.2 The device shall be assembled and tested with each of the sizes and types of flexible cords or cable that it will physically accommodate following the instructions provided by the manufacturer. Proper assembly shall be determined by visual examination and compliance with the tests described in Sections 18 – 37. Special consideration shall be given to conductor and jacket strip length, keying, color coding, support, and the like.

37.5 Accelerating aging tests

37.5.1 A device employing a rubber, EPDM, or TEE compound shall not show any apparent deterioration and no greater change in hardness than ten units as a result of the test described in 37.5.2 and 37.5.3.

37.5.2 A complete device is to be used for this test. The hardness of the material is to be determined as the average of five readings with an appropriate gauge, such as the Rex hardness gauge or the Shore durometer. The device is to be placed in a full-draft air-circulating oven for 70 h at a temperature of 100°C (212°F). The device is to be allowed to rest at room temperature for four or more hours after removal from

the oven. The hardness is to be determined again as the average of five readings. The difference between the average original hardness reading and the average reading taken after exposure is the change in hardness.

Exception: As an alternative to testing on a complete device, representative plaques or bars of the insulating material which measure a minimum of 1 in (25.4 mm) in diameter by 1/4-in (6.4-mm) thick are to be used.

37.5.3 The accelerated-aging tests described in 37.5.1 and 37.5.2 are to be made on each color of material and on each basic rubber, EPDM, or TEE material employed for the device.

37.6 PVC compounds and copolymers

37.6.1 A device employing polyvinyl chloride or one of its copolymers shall not show any cracks, severe discoloration, or other visible signs of deterioration of the molding material as a result of this test.

37.6.2 The device is to be placed in a full-draft air-circulating oven for 96 h at a temperature of 100°C (212°F). The device is to be allowed to rest at room temperature for at least one hour after removal from the oven. Warping or distortion of the device housing that occurs as a result of the oven conditioning shall not be considered to be a sign of deterioration.

Exception: As an alternative to testing on a complete device, representative plaques or bars of the insulating material which measure a minimum of 1 inch (25.4 mm) in diameter by 1/4-in (6.4-mm) thick are to be used.

37.7 Crushing test for valve connectors only

37.7.1 Six samples of the valve connectors are to tested. Prior to testing, the samples are to be conditioned in a circulating-air oven for 7 days at 90 ±1°C (194 ±1.8°F). The samples are to be removed from the oven and allowed to cool to room temperature. Each sample is to be placed between two 1/2 in (12.7 mm) or thicker parallel flat maple blocks. A force of 75 lbf (334 N) is to be gradually applied in a direction normal to the major axis of the sample for a period of 1 min.

37.7.2 As a result of the test in 37.7.1 there shall no be any cracking or breaking to the extent that:

a) The fitting becomes unfit for use, or

b) Live parts become exposed to unintentional contact.

37.8 Impact test for valve connectors only

37.8.1 Six samples of the valve fittings are to be mounted as intended and subjected to this test and cooled to a temperature of 0 ±2°C (32 ±3.6°F) for 3 hours. While the units were still cool, the samples are to backed by a rigid supporting surface. Immediately following the removal of the samples from the cooling chamber, the samples are to be subjected to impact forces of 5 ft·lb (7 J) using a 2-in (50.8-mm) diameter steel ball, weighing 1.18 lbs. After the impacts, a dielectric test in accordance with Section 21 is to be performed on each sample.

37.8.2 As a result of the tests in 37.8.1 there shall be no reduction in spacings below the minimum allowable, as specified in 12.1, exposing live parts or internal wiring, or any other condition that increases the shock or fire hazard of the equipment. There shall be no dielectric breakdown.

37.9 Low temperature test for valve connectors only

37.9.1 Six samples are to be subjected to this test. Each sample is to be mounted to a solenoid assembly. The assemblies are to be cooled in a circulating air to a temperature of −40 ±2.0°C (−104.0 ±3.6°F) for a period of 3 h. Within 15 s after removal from the cold chamber, the chilled assemblies are to be subjected separately to an impact of 5 ft·lbs or 7 J or 0.691 m·kgf directed vertically downward onto the center of the surfaces judged to be most severe. The impact is to be delivered by a solid, steel sphere falling through a distance of 51 in (1295 mm). The sphere is smooth, 2 in (50.8 mm) in diameter and weighed 1.18 lb (535 g). After the impacts, a dielectric test in accordance with Section 21 is to be performed on each sample.

37.9.2 As a result of the tests in 37.9.1 there shall be no reduction in spacings below the minimum allowable, as specified in 12.1 exposing live parts or internal wiring or any other condition that increases the shock or fire hazard of the equipment. There shall be no dielectric breakdown.

37.10 Tests for permanence of flag type cord or cable tag

37.10.1 For the following tests, printed production-type flag type cord or cable tags are to be provided with all the required markings printed in accordance with the requirements specified in this standard (i.e. required letter height, etc.) and in a contrasting color to the solid background. To determine compliance with 40.1.2, the samples that have been subjected to the applicable conditions described in 37.12 shall meet the following requirements. The tests shall be conducted in the following order:

a) Visual Examination – The cord or cable tag shall be visually examined with normal or corrected vision following each applicable exposure conditioning for the following:

1) There shall not be any permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible.

b) Defacement Test (Overlaminated Cord Tags Only) – Following each applicable exposure, the flag type cord or cable tag is to be scraped back and forth 10 times across the printed surface and edges with a downward force of 2 lbf (8.9 N) using the edge of a 5/64-in (1.9-mm) thick steel blade. The blade is to be held perpendicular to the cord surface. The portion of the blade in contact with the surface shall have an approximate radius of curvature of 1 in (25.4 mm) and shall be rounded to a minimum radius of 1/64 in (0.4 mm). The cord or cable tag shall be examined as follows:

1) The flag type cord or cable label and overlamination shall not move more than a 1/2 in (12.7 mm) along the cord or cable and shall not be torn a distance greater than 1/16 in (1.6 mm) or otherwise damaged. The printing shall remain legible.

c) Tearing and Separation Test – The cord or cable assembly, with the fitting pointing up, is to be held taught in a vertical plane. A force of 5 lbf (22.2 N), which includes the weight of the clamp, is to be applied for 1 min to the uppermost corner of the flag type cord or cable tag farthest from the device, within 1/4 in (6.4 mm) of the vertical edge of the tag. The force is to be applied by affixing a C-clamp with a pad diameter of 3/8 in (9.5 mm) to the tag and securing the weight to the C-clamp. The force is to be applied vertically downward in a direction parallel to the major axis of the cord or cable. The flag type cord or cable tag shall be examined as follows:

1) The flag type cord or cable tag shall resist tearing for longer than 1/16 in (1.6 mm) at any point.

2) The flag type cord or cable tag shall not separate from the cord or cable assembly. A hang-type tag shall not separate from the securement strap, and the securement strap shall not separate from the cord or cable assembly;

3) The flag type cord or cable tag or securement strap shall not slip or move along the length of the cord or cable assembly more than 1/2 in (13 mm) and there shall not be any visible damage to the cord.

Exception: A flag type cord or cable tag that complies with the applicable requirements in Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, and is rated for the cord or cable type and size, for the intended use (i.e. indoor or outdoor use, lubricating oil resistant) of the cord and cable assembly, and for the limited slippage rating, is not required to comply with this test.

37.11 Tests for permanence of wrap around cord or cable label

37.11.1 For the following tests, printed production-type wrap around cord or cable labels are to be provided with all the required markings printed in accordance with the requirements specified in this standard (i.e. required letter height, etc.) and in a contrasting color to the solid background. To determine compliance with 40.1.2, the samples that have been subjected to the test conditions described in 37.12 shall meet the following requirements. The tests shall be conducted in the following order:

a) Visual Examination – A wrap around cord or cable label shall be visually examined with normal or corrected vision following each applicable exposure condition for the following:

1) A wrap around cord or cable label shall adhere to the surface to which it is applied without any significant evidence of curling or loosening around the perimeter or other indication of loss of adhesion such as wrinkles or bubbles.

2) It shall not excessively craze or shrink.

3) The printed text shall remain legible. Discoloration or fading is not to be considered a failure.

b) Legibility Test – Following each applicable exposure condition, the printed surface of the wrap around cord label is to be rubbed with finger pressure back and forth 10 times with a downward force of 4 lbf (17.8 N). This test does have to be conducted on samples employing an over-lamination or that are subsurface printed.

1) The printed text shall remain legible.

c) Defacement Test – Following each applicable exposure, the wrap around cord or cable label is to be scraped back and forth 10 times across the printed surface and edges with a downward force of 2 lbf (8.9 N) using the edge of a 5/64-in (1.9-mm) thick steel blade. The blade is to be held perpendicular to the cord surface. The portion of the blade in contact with the surface shall have an approximate radius of curvature of 1 in (25.4 mm) and shall be rounded to a minimum radius of 1/64 in (0.4 mm). The wrap around cord or cable label shall be examined as follows:

1) The wrap around cord or cable label and/or overlamination, if provided, shall not move more than a 1/2 in (12.7 mm) along the cord and shall not be torn or removed from the cord or cable surface.

Exception: A flag type cord or cable tag that complies with the applicable requirements in Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, and is rated for the cord or cable type and size, for the intended use (i.e. indoor or outdoor use, lubricating oil resistant) of the cord and cable assembly, and for the limited slippage rating, is not required to comply with this test

37.12 Test conditions

37.12.1 For each type of conditioning mentioned in 37.12.2 – 37.12.4, three flag type cord or cable tags applied to the applicable cable assemblies in the intended manner are to be used or three wrap around cord or cable labels applied to the applicable cable assembly. For flag type cord or cable tags or wrap around cord or cable labels applied by an adhesive, tests are to be conducted no sooner than 24 h after application of the flag type cord or cable tag or wrap around label.

37.12.2 Each of three flag type cord or cable tags or wrap around cord or cable labels are to be tested as received.

37.12.3 Each of three flag type cord or cable tags or wrap around cord or cable labels are be tested after 30 min of conditioning at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity, following 240 h of conditioning in an air-circulating oven at 60 ±1°C (140 ±1.8°F).

37.12.4 Each of three flag type cord or cable tags or wrap around cord or cable labels are to be tested within 1 min after being exposed for 72 h to a relative humidity of 85 ±5% at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

37.12.5 If the flag type cord or cable tags or wrap around cord or cable labels are intended to be applied to an outdoor cord or cable assembly, the flag type cord or cable tag or wrap around cord or cable label are to be conditioned as follows and in 37.12.6 – 37.12.7. Each of three flag type cord or cable tags or wrap around cord or cable labels are to be tested after 24 h of exposure conditioning at 23 ±2°C (73.4 ±3.6°F) and 50 ±5% relative humidity, followed by 48 h of immersion to a depth of not less than 1/8 inch (3.2 mm) in demineralized water at a temperature of 23°C (73.4°F).

37.12.6 Each of three flag type cord or cable tags or wrap around cord or cable labels are to be tested after 24 h of exposure conditioning at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5% relative humidity, followed by 7 h of exposure in a cold box at a temperature of -10 ±2°C (14.0 ±3.6°F).

37.12.7 Each of three flag type cord or cable tags or wrap around cord or cable labels are to be tested after 24 h of exposure conditioning at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5% relative humidity, followed by exposure to ultraviolet light and water spray with ultraviolet light by using either of the following apparatus:

a) A Twin-Enclosed Carbon-Arc Weatherometer, (Type D or DH), as described in the Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials ASTM G152 and the Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G153. Each of the tags is to be exposed to 720 h of ultraviolet light and water spray with ultraviolet light. The operating cycle is to be 20 min; 17 min of ultraviolet light only and 3 min of water spray and ultraviolet light.

b) A Xenon-Arc Weatherometer, (Type B or similar apparatus), as described in the Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, ASTM G155. Each of the tags is to be exposed to 1000 h of ultraviolet light and water spray with ultraviolet light. The exposure shall be in accordance with Method A, with continuous exposure to ultraviolet light and intermittent water spray with ultraviolet light, using a programmed cycle of 120 min (102 min ultraviolet light exposures and an 18 min exposure to water spray with ultraviolet light). The apparatus shall include a 6500 W, water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0.35 W/m^2 at 340 nm and a black-panel temperature of 63.0 ±3.0°C (145.0 ±5.4°F).

37.12.8 If the flag type cord or cable tags or wrap around cord or cable labels are intended to be applied to an indoor or outdoor cord or cable assembly that is required to be oil resistant, the flag type cord or cable tag or wrap around cord or cable label are to be conditioned as follows. Each of three tags is to be

tested within 2 h after being immersed for 48 h in IRM 902 oil at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F).

MANUFACTURING AND PRODUCTION TESTS

38 Dielectric Voltage-Withstand Test

38.1 Each device (all molded-on and any device that is assembled prior to been shipped to the OEM) shall withstand without electrical breakdown, as a routine production-line test, the application of an ac potential at a frequency within the range of 40 – 70 Hz or a dc potential, between live parts and accessible dead metal parts that are likely to become energized, and between primary wiring and accessible low-voltage (42.4 V_{peak} or less) metal parts, including terminals.

38.2 The test potential shall be in accordance with Condition A or Condition B of Table 38.1. The full test potential is to be applied for the full time specified in Table 38.1. The Condition A test potential may be applied gradually until the full test potential is attained. For the Condition B, 1-s test, the full test potential shall be applied at the beginning of the test.

Exception: A test potential of 500 V is to be applied to a device rated 30 V_{rms} (42.4 V_{peak}) or less for a period of 1 min, or 600 V for a period of 1 s.

Table 38.1
Production-line test potential

Condition A			Condition B		
Minimum test potential		Time	Minimum test potential		Time
V_{dc}	V_{ac}	s	V_{dc}	V_{ac}	s
1400+2.8V[a]	1000+2V[a]	60	1700+3.4V[a]	1200+2.4V[a]	1
[a] Maximum marked voltage.					

38.3 The test shall be conducted when the device is complete (fully assembled). It is not intended that the device be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover, that would interfere with conducting the test need not be in place.

Exception No. 2: The test may be conducted before final assembly if the test represents that for the completed product.

38.4 A device employing a solid-state component that is not relied upon to reduce a risk of electric shock and that can be damaged by the dielectric potential may be tested before the component is electrically connected provided that a random sampling of each day's production is tested at the potential specified in Table 38.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state component damage while retaining representative dielectric stress of the circuit.

38.5 The test equipment shall include a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic feature that rejects any unacceptable unit. If an ac test potential is applied, the test equipment shall also include a transformer having an essentially sinusoidal output.

38.6 If the output of the test-equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to indicate the test potential directly.

38.7 If the output of the test-equipment transformer is 500 VA or more, the test potential may be indicated by:

a) A voltmeter in the primary circuit or in a tertiary-winding circuit,

b) A selector switch marked to indicate the test potential, or

c) A marking in a readily visible location to indicate the test potential in the case of equipment having a single test-potential output.

Exception: When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

38.8 Test equipment other than that described in 38.5 – 38.7 may be used if found to accomplish the intended factory control.

RATINGS

39 General

39.1 A device shall be rated in volts ac, dc, or both and amperes. A device may have multiple voltage and current ratings.

39.2 The ampere rating of a device shall be specified by the manufacturer.

MARKINGS

40 Details

40.1 General

40.1.1 Unless otherwise indicated, markings required by this standard shall be clearly visible, readily legible, and placed on the outside of the enclosure. When required, the words "CAUTION," "WARNING," or "DANGER" in the first element of each statement are to be boldface capital letters and a minimum of 3/32-in (2.4-mm) high, and the remaining words are to be a minimum of 1/16-in (1.6-mm high).

40.1.2 Markings required by this standard shall be permanent. A permanent marking shall be molded, die-stamped, or paint-stenciled; stamped or etched metal that is permanently secured; or indelibly stamped on a pressure-sensitive label secured by adhesive that complies with the Standard for Marking and Labeling Systems, UL 969 or provided on a cord or cable tag that complies with 37.10 or 37.11. Ordinary usage, handling, storage, and the like of the unit are to be evaluated in determining whether a marking is permanent.

40.1.3 A device shall be legibly marked, where readily visible after installation, with the manufacturer's name, trade name, trademark, or other descriptive marking to identify the organization responsible for the device.

Exception: The marking is acceptable on the smallest unit container if the device is too small, or the legibility is difficult to attain.

40.1.4 The following shall be marked on the device, on the smallest unit container, or on a stuffer sheet in the smallest unit container:

a) The catalog number or an equivalent designation,

b) The electrical rating,

c) Whether ac, dc, or both. A wiring device that is intended for ac use only shall be identified by "AC" or "AC only," and

d) When intended for a specific application, the type of application in which the device is intended to be used.

40.1.5 If a device is produced or assembled at more than one factory, each finished device shall have a distinctive marking, which may be in traceable code, to identify the factory of origin.

Exception: The marking is acceptable on the smallest unit container if the device is too small, or the legibility is difficult to attain.

40.1.6 A device shall be marked with the following or with an equivalent statement, "Not for current interrupting" or "For disconnecting use only." This statement shall appear on the device or on a flag label wrapped around the cord as close to the fitting as possible or on the smallest unit container or package. When a flag label is used it shall comply with 37.10.

Exception No. 1: A device that has been investigated for either across-the-line ac motor starting, single, 2- and 3- phase or for across-the-line dc motor starting and complies with the overload, temperature, and resistance to arcing testing, as described in Table 18.1 are not marked as described in 40.1.6.

Exception No. 2: A device that has been investigated for ac general use and complies with the overload, temperature, and resistance to arcing testing, as described in 24A.4A shall be marked "General Use Circuit Interruption Only" or equivalent, are not marked as described in 40.1.6.

Exception No. 3: A device that has been investigated for dc general use and complies with the overload, temperature, and resistance to arcing testing, as described in 24A.5A shall be marked "General Use Circuit Interruption Only" or equivalent, are not marked as described in 40.1.6.

40.1.7 A device that is assembled on or intended for use with appliance wiring material that is suitable for internal use only shall be marked "For use within equipment only" or equivalent. This statement shall appear on the device or on a flag label wrapped around the cord as close to the fitting as possible.

Exception: This marking is not required on inlets and outlets.

40.1.8 The tightening torque for field-wiring terminals shall be marked on the device, the smallest unit shipping container, or a stuffer sheet in the smallest unit shipping container.

40.1.9 With reference to 16.1, when the mounting means for a panel mounted device is provided as a kit, the kit shall be referenced in a marking or in the instructions provided by the manufacturer.

40.1.10 A device complying with Environmental Enclosure Tests, Section 30, shall be marked with the environmental type, for example, "Type ___ Enclosure," for which the device is intended. A device that complies with the requirements for more than one type of environment shall have multiple designations. The marking shall be visible after installation.

40.1.10A With reference to 17.5, a Type 4 or Type 4X enclosure intended for indoor use only shall be marked, respectively, "4 Indoor Use Only", or "4X Indoor Use Only" in letters at least 5/32 in (4.0 mm) high.

40.1.11 If a Type 6 or 6P environment rated disconnectable device can be disconnected from the intended mating device without the use of a tool after the devices have been installed as intended, fully connected, and submerged, the devices shall be marked "CAUTION" and the following or the equivalent: "Risk of Electric Shock. Do not disconnect while female cable fitting is submerged." The marking shall be visible after installation.

40.1.12 Devices that meet Exception No. 4 of 7.2.1 shall be marked "For Use In Class 2 Circuits Only" or equivalent.

40.1.13 Fittings and devices that employ components and/or circuitry (Type 4 component assemblies or Type 5 surge protective components) to provide surge protection of integral functionality that have not also been evaluated for Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449, for the protection of connected equipment or wiring shall not be marked to imply that the fittings or devices provide external surge protection.

40.1.14 Fittings and devices that have also been evaluated for Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449, for the protection of connected equipment or wiring shall also be marked in accordance with the marking requirements for, respectively, Type 2 or Type 3 surge protective devices.

40.1.15 A shielded cord shall be marked with the word "shielded" on the outer surface of the cord.

40.1.16 Markings and instructions that are alternatively permitted on a stuffer sheet, information sheet may be provided via a manufacturer's web site. The web address shall be marked on the device, packaging and/or information sheet. The web address may be in the form of a Uniform Resource Locator (URL – http://www.___.com/___/), or as a Quick Response Code (QRcode). The web address link shall take the user to an internet page containing the required information or a direct link to the required information. The file shall be a file format that is commonly used and may be downloadable. This does not apply to markings that are specified to be located on the device or the packaging/container only (not a stuffer sheet) but this information may be repeated on the web site.

40.2 Feeder-tap cable systems

40.2.1 Markings

40.2.1.1 In addition to the markings prescribed in General, 40.1, a feeder-tap cable system not intended for disconnect under load shall be marked with the statement "Do not disconnect under load" or equivalent where visible after installation.

40.2.2 Instructions

40.2.2.1 A feeder-tap cable system shall be provided with installation instructions that contain the following information:

a) Tightening torque for field-wiring terminals,

b) For the feeder cable, the intended cable types, conductor size or sizes (in AWG), total number of conductors, and the overall cable diameter range when the device is intended to be used with a limited range of the cable diameters available within that type,

c) For the tap conductors, the intended flexible cord types, conductor size or sizes (in AWG), total number of conductors, and the overall cord diameter range when the device is intended to be used with a limited range of the flexible cord diameters available within that type, and

d) Instructions for assembling the device to the cable and cord, including any specific instructions concerning cable or flexible cord preparation.

40.2.2.2 The installation instructions for a feeder-tap cable system employing pin-type (insulation piercing) or insulation-displacement terminals shall include the following or equivalent: "CAUTION – To Reduce the Risk of Electric Shock, Do not strip wires. Cut off end of cord cleanly."

40.3 Field assembled cable system

40.3.1 Markings

40.3.1.1 In addition to the markings prescribed in General, 40.1, a field assembled cable system shall be marked in accordance with 40.3.1.2.

40.3.1.2 A device that is field assembled on and intended for use with flexible cord or cable shall be marked with the following on the smallest unit shipping carton, on an instruction sheet provided in the carton, or on the device:

a) The flexible cord or cable types,

b) The conductor size or sizes,

c) The total number of conductors, and

d) The overall cord diameter when the device is intended to be utilized with a limited range of cord diameters available for a cord.

INSTRUCTIONS

41 Installation and Operating Instructions

41.1 General

41.1.1 Installation and operating instructions shall be provided with each device intended to be field assembled. The instructions are to be used as a reference in the examination and test of the product.

Exception: This information may alternatively be via a manufacturer's web site. See 40.1.16.

41.1.2 The instructions shall include such directions and information as necessary to cover the intended installation and maintenance of the devices. These instructions shall include, but not be limited to, such items as keying, color-coding, support, strip length of conductors, and overload protection.

41.1.3 Detailed instructions shall be provided for the wiring of each assembly in which any wiring is intended for field connection.

41.1.4 Detailed instructions shall be provided for the field assembly into recommended configurations.

41.1.5 The installation and operating instructions for a device that is intended to be field assembled onto flexible cord shall include:

a) The flexible cord or cable types,

b) The conductor size or sizes,

c) The total number of conductors, and

d) The overall cord diameter when the device is intended to be utilized with a limited range of cord diameters available for a cord.

Exception: This information may alternatively be marked on be the smallest unit shipping carton, or on the device.

41.1.6 The installation and operating instructions for a device that is intended to be field assembled onto conductors only shall include:

a) The conductor size or sizes,

b) The total number of conductors.

Exception: This information may alternatively be marked on be the smallest unit shipping carton, or on the device.

41.1.7 Installation and operating instructions for fittings and devices that employ components and/or circuitry (Type 4 component assemblies or Type 5 surge protective components) to provide surge protection of integral functionality that have not also been evaluated for Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449, for the protection of connected equipment or wiring shall explicitly indicate that the fittings or devices are not suitable as surge protective devices for connected equipment and wiring.

41.1.8 Installation and operating instructions for fittings and devices that have also been evaluated for Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449, for the protection of connected equipment or wiring shall comply with the instructions requirements for, respectively, Type 2 or Type 3 surge protective devices.

41.2 Wiring information – field wiring terminals

41.2.1 The value of tightening torque assigned in accordance with 10.8 shall be marked where readily visible:

a) On the device;

b) On the smallest unit container; or

c) On an information sheet packed in the smallest unit container.

41.2.2 If field wiring terminals employing solder connections are intended for solid, stranded tinned, or tin dipped stranded conductors only, instructions regarding the use of solid wire or the tinning of stranded wire shall be marked where readily visible:

a) On the device;

b) On the smallest unit container; or

c) On an information sheet packed in the smallest unit container.

41.2.3 Crimp terminal installations instructions, including conductor size(s) and type(s) and crimp tool(s) designation shall be marked where readily visible:

a) On the device;

b) On the smallest unit container; or

c) On an information sheet packed in the smallest unit container.

41.2.4 Devices intended for use with conductors rated 167°F (75°C) or higher and so marked shall not intermate with similar devices not so marked. If the device is rated 100 A or less and is intended for use with conductors having 167°F (75°C) insulation, the device shall be marked with the temperature rating of the insulation. If a device is intended for use with conductors having a temperature rating higher than 140°F (60°C) but is intended to be used based on 140°F (60°C) ampacities, the minimum conductor size shall be indicated on the device, as well as on the smallest unit shipping carton, or on an instruction sheet provided in the carton.

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SUPPLEMENT SA – Short Circuit Current Rated (SCCR) Cable Assemblies and Fittings for Industrial Control and Signal Distribution

INTRODUCTION

SA1 Scope

SA1.1 The requirements of this Supplement cover Cable Assemblies and Fittings for Industrial Control and Signal Distribution provided with an identified Short-Circuit Current Rating (SCCR). These requirements are optional and supplement the requirements contained elsewhere in this standard.

SA2 Glossary

SA2.1 For the purposes of this Supplement, the following definitions apply.

SA2.2 SHORT CIRCUIT CURRENT RATING – Rating on cable assemblies and fittings representing the maximum level of short-circuit current that a component or assembly can withstand.

SA3 General

SA3.1 Cable Assemblies and Fittings for Industrial Control and Signal Distribution shall comply with all requirements in the Standard for Cable Assemblies and Fittings for Industrial Control and Signal Distribution, UL 2238.

CONSTRUCTION

SA4 General

SA4.1 General

SA4.1.1 All terminals of Cable Assemblies and Fitting for Industrial Control and Signal Distribution shall be assembled or provided as a complete assembly as intended, according to the manufacturer's instructions.

SA4.2 Short circuit current ratings

SA4.2.1 All Cable Assemblies and Fitting for Industrial Control and Signal Distribution shall have a short circuit current rating expressed in amperes or kilo- amperes and voltage.

PERFORMANCE

SA5 Short-Circuit Withstand Test

SA5.1 General

SA5.1.1 A device shall be subjected to the tests in accordance with SA5.2.1 – SA5.2.2 when protected by a fuse or circuit breaker as specified in SA5.2.1 and SA5.2.2. The overcurrent protective device used shall have an interrupting rating at least equal to the test current. See Section SA6.

SA5.1.2 If such equipment is marked to limit protection to fuses only, it shall not be considered as intended for use in a circuit protected by an inverse-time circuit breaker.

SA5.1.3 Testing with inverse-time circuit breakers shall not be required if it is shown that the clearing time of the inverse-time circuit breakers will be less than that of the fuse with which the product has been tested. Testing with inverse-time circuit breakers is not required when it is shown that the let-through

energy (I^2t) and peak let-through current (I_p) of the inverse-time circuit breakers is less than that of the fuse with which the product has been tested.

SA5.2 Protective devices

SA5.2.1 The fuses used for the tests shall be specified as follows:

a) For a device intended for use on general purpose branch circuits, the rating of the fuse used shall be the ampere rating of the device.

b) For a device intended for use on motor branch circuits, the fuses used for the tests shall be specified by the manufacturer in accordance with Table SA5.1.

Table SA5.1
Ratings of fuses used for test

Type of fuse[a]	Maximum percent of device rated current[b]	Fuse Current (Amp) marking required[h]	Fuse Type (Class) marking required[i]
Nontime delay	400[c,d]	No	Yes
Nontime delay	< 400 but ≥300[e]	Yes	Yes
Nontime delay	<300 but >225[f]	Yes	Yes
Time delay	≤225g	Yes	Yes

[a] Tests with 225% full load ampere time delay fuses are not representative of tests with 400% full load ampere non-time delay fuses.

[b] These values are to be used when the manufacturer does not specify fuse sizes and refers to a maximum percent level, such as "Fuse not to exceed 300% of motor full load amps."

[c] For non-time delay fuses, if the calculated value of the fuse is between two standard ratings as specified in SA5.2.3, a fuse of the nearest standard rating but not more than four times the full-load motor-current rating is to be used.

[d] Tests with 400% non-time delay fuses cover use with 225% time delay fuses.

[e] Tests with non-time delay fuses rated less than 400%, and equal to or greater than 300 percent cover use with 175% time delay fuses.

[f] Tests with less than 300% non-time delay fuses requires additional testing with 225% (or as marked) time delay fuses.

[g] The product is marked to indicate the level of protection and that the branch-circuit protective device is able to be of the time-delay type.

[h] When the fuse size employed for the short circuit test requires a marking, the device shall be marked as specified in Section SA6.

[i] For Fuse Type (Class) see Section SA6, Markings.

SA5.2.2 Standard ampere ratings for fuses are 1, 3, 6, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 601, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, and 4000.

SA5.2.3 Testing shall be conducted with Class RK5 fuses.

Exception: Other class of fuses may be used, if the device is marked to indicate the Class Type of fuse. See marking in SA6.4.

SA5.2.4 For a device intended to be used with fuses and short circuit rating greater than 5,000 A, the protective devices used for the test are to be sized in accordance with SA5.2.1 and are to be selected as follows:

apacity, current-limiting types – for example, Class CC, G, J, L, R, and T.