UL 1703

STANDARD FOR SAFETY

Flat-Plate Photovoltaic Modules and Panels

UL Standard for Safety for Flat-Plate Photovoltaic Modules and Panels, UL 1703

Third Edition, Dated March 15, 2002

SUMMARY OF TOPICS

The revision of ANSI/UL 1703 dated November 25, 2019 New Fire Type Additions and Revisions to Existing Types in Fire Performance – PV Modules or Panels and Roofs, Section 16.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 20, 2019.

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

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MARCH 15, 2002
(Title Page Reprinted: November 25, 2019)

ANSI/UL 1703-2019

UL 1703

Standard for Flat-Plate Photovoltaic Modules and Panels

First Edition – August, 1986
Second Edition – May, 1993

Third Edition

March 15, 2002

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through November 25, 2019.

The most recent designation of ANSI/UL 1703 as an American National Standard (ANSI) occurred on November 7, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover flat-plate photovoltaic modules and panels intended for installation on or integral with buildings, or to be freestanding (that is, not attached to buildings), in accordance with the National Electrical Code, NFPA 70, and Model Building Codes.

1.2 These requirements cover modules and panels intended for use in systems with a maximum system voltage of 1500 V or less.

1.3 These requirements also cover components intended to provide electrical connection to and mounting facilities for flat-plate photovoltaic modules and panels.

1.4 These requirements do not cover:

a) Equipment intended to accept the electrical output from the array, such as power conditioning units (inverters) and batteries;

b) Any tracking mechanism;

c) Cell assemblies intended to operate under concentrated sunlight;

d) Optical concentrators; or

e) Combination photovoltaic-thermal modules or panels.

1.5 *Deleted*

2 Glossary

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

2.2 AIR MASS (AM) – A dimensionless quantity, the ratio of:

a) The actual path length of radiation through the atmosphere to

b) The vertical path length of radiation through the atmosphere to sea level. At sea level, for all but very high zenith angles (θ_z) (the angle subtended by the zenith and the line of sight to the sun),

$$AM = \sec\theta_z$$

2.3 ARRAY – A mechanically-integrated assembly of modules or panels with a support structure and foundation, tracking, thermal control, and other components, if used, to form a dc power-producing unit.

2.3.1 BIFACIAL PV MODULE – A PV module that is constructed to allow illumination from the super and substrate to be transmitted to the PV cells that are capable of generating power from both front and back surfaces.

2.3.2 BIFACIALITY COEFFICIENT – The ratios between the main electrical characteristics of the rear side and the front side of a bifacial PV module, at Standard Test Conditions (STC) unless otherwise specified for short circuit current, open circuit voltage and maximum power point.

2.4 BLOCKING DIODE – A diode used to block reverse current into a photovoltaic-source circuit.

2.5 BYPASS DIODE – A diode connected across one or more cells, modules, or panels in the forward current direction to allow current to bypass such cells, modules, or panels.

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

2.7 ELECTRIC SHOCK – A risk of electric shock is considered to exist at a part if the potential between the part and earth ground or any other accessible part is more than 30 Vdc and the leakage current exceeds the values specified in Table 21.1.

2.8 ENCAPSULANT – Transparent insulating material enclosing the cells and cell interconnects.

2.8.1 INHERENTLY LIMITED – Refers to a type of Class 2 Power Source which does not require a separate means to automatically reduce the output levels or de-energize the output circuit as a means of remaining within Class 2 Power Source limits.

2.9 INTERCONNECT – A conductor within a module that provides a mechanism for conducting electricity between cells.

2.10 MAXIMUM POWER (P_{max}) – The point on the current-versus-voltage curve of a module, at STC, where the product of current and voltage is maximum.

2.11 MAXIMUM SYSTEM VOLTAGE – The sum of the maximum open-circuit voltages of the maximum number of modules or panels to be connected in series in a system.

2.12 METALLIZATION – An electrically conductive metal coating on the surface of a cell.

2.13 MODULE (FLAT-PLATE) – The smallest environmentally protected, essentially planar assembly of solar cells and ancillary parts, such as interconnects and terminals, intended to generate dc power under unconcentrated sunlight. The structural (load-carrying) member of a module can either be the top layer (superstrate), or the back layer (substrate), in which:

a) The superstrate is the transparent material forming the top (light-facing) outer surface of the module. If load-carrying, this constitutes a structural superstrate.

b) The substrate is the material forming the back outer surface of a module. If load-carrying, this constitutes a structural substrate.

2.14 NOMINAL OPERATING CELL TEMPERATURE (NOCT) – The equilibrium cell junction temperature corresponding to nominal module service operating conditions in a reference environment of 80 mW/cm^2 irradiance, 20° C (68° F) ambient air temperature, 1 m/s wind across the module from side to side, an electrically open circuit, and a mounting method in accordance with 19.6 and 19.7.

2.15 PANEL (FLAT-PLATE) – A collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit.

2.16 RATED OPERATING VOLTAGE – The voltage, ±10 percent, at which maximum power is available from the module or panel under STC.

2.16.1 REVERSE CURRENT – Current flowing in a reverse direction to the normal direction resulting from a normally illuminated PV module.

2.17 STANDARD TEST CONDITIONS (STC) – Test conditions consisting of:

a) 100 mW/cm^2 irradiance,

b) AM 1.5 spectrum, and

c) 25°C cell temperature.

2.18 UNCONDITIONED MODULES OR SPECIMENS – Modules or specimens that have not been previously subjected to tests or environmental exposures.

3 Units of Measurement

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

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 generally used in the products covered by this standard.

4.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component 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 References

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

CONSTRUCTION

6 General

6.1 A module shall be completely assembled when shipped from the factory. A panel may be completely assembled when shipped from the factory, or may be provided in subassemblies, provided assembly of the panel does not involve any action that is likely to affect compliance with the requirements of this standard.

Exception: An assembly part need not be affixed to the module at the factory.

6.2 A module or panel assembly bolt, screw, or other part shall not be intended for securing the complete device to the supporting surface or frame.

6.3 Incorporation of a module or panel into the final assembly shall not require any alteration of the module or panel unless specific details describing necessary modification(s) for alternate installation(s) are provided in the installation instructions. If a module or panel must bear a definite relationship to

another for the intended installation and operation of the array (for example, to allow connectors to mate), it shall be constructed to permit it to be incorporated into the array in the correct relationship without the need for alteration.

6.4 The construction of a product shall be such that during installation it will not be necessary to alter or remove any cover, baffle, insulation, or shield that is required to reduce the likelihood of:

a) Excessive temperatures, or

b) Unintentional contact with a part that may involve a risk of electric shock.

Exception: A cover of a wiring compartment providing access to a connection means that may involve a risk of electric shock may be removable to allow for the making of electrical connections.

6.5 Parts shall be prevented from loosening or turning if such loosening or turning may result in a risk of fire, electric shock, or injury to persons.

6.6 Friction between surfaces is not acceptable as the sole means to inhibit the turning or loosening of a part, but a lock washer properly applied is acceptable for this purpose.

6.7 An adjustable or movable structural part shall be provided with a locking device to reduce the likelihood of unintentional shifting, if any such shifting may result in a risk of fire, electric shock, or injury to persons.

6.8 Metals used in locations that may be wet or moist shall not be employed in combinations that could result in deterioration of either metal such that the product would not comply with the requirements in this standard.

6.9 Edges, projections, and corners of photovoltaic modules and panels shall be such as to reduce the risk of injury to persons.

6.10 Whenever a referee measurement is necessary to determine that a part as mentioned in 6.9 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the requirements in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be employed.

7 Polymeric Materials

7.1 A polymeric material system serving as the enclosure of a part involving a risk of fire or electric shock shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, concerning:

a) Flammability,

b) Ultraviolet light exposure,

c) Water exposure and immersion, and

d) Hot-wire ignition (HWI).

Exception: The flammability tests prescribed in UL 746C do not apply to the superstrate, encapsulation, and substrate. These materials shall comply with 7.4.

7.2 A polymeric material that is in contact with or in close proximity, less than 0.8 mm (1/32 in), to uninsulated live parts shall:

a) Have a flammability classification of HB, V-2, V-1, or V-0 determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

b) Have a minimum High-Current Arc Ignition performance level category (PLC) in accordance with the following:

Flammability classification	High-current arc ignition, PLC
HB	1
V-2	2
V-1	2
V-0	3

c) Have a Comparative Tracking Index performance level category (PLC) as determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, and as defined in Table 7.1, when the system voltage rating is 600 V or less;

Exception No. 1: The CTI rating is not required when both the material and live part are completely encapsulated by potting material such that there is no surface upon which tracking may occur, and the potting material has been evaluated according to UL 746C, Table 6.1, for Electric Strength, Resistance to Electrical Ignition Sources (HAI and HWI), and Thermal Endurance.

Exception No. 2: The CTI rating is not required when both the material and live part are completely coated by a conformal coating that has been evaluated to the requirements of the Standard for Polymeric Materials - Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E, Section 22, at the rated thickness such that there is no surface upon which tracking may occur.

Exception No. 3: Single component silicone rubber based room temperature vulcanizing (RTV) materials when applied in accordance with Exception No. 2 is considered a suitable conformal coating without further evaluation.

d) Have an Inclined Plane Tracking (ASTM D2303) rating of 1 h using the time to track method at the higher of system voltage or 1000 V when the system voltage is in the range of 601 – 1500 V, as specified in Table 7.1; and

Exception No. 1: The 1 hr rating is not required when both the material and live part are completely encapsulated by a potting material such there is no surface upon which tracking may occur, and the potting material has been evaluated according to UL 746C, Table 6.1, for Electric Strength, Resistance to Electrical Ignition Sources (HAI and HWI), and Thermal Endurance.

Exception No. 2: The 1 hr rating is not required when both the material and live part are completely coated by a conformal coating that has been evaluated to the requirements of UL 746C, Section 43A, at the rated thickness such that there is no surface upon which tracking may occur.

Exception No. 3: Single component silicone rubber based room temperature vulcanizing (RTV) materials when applied in accordance with Exception No. 2 is considered a suitable conformal coating without further evaluation.

e) Comply with the requirements for exposure to ultraviolet light as determined in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, when exposed to light during normal operation of the product. Polymeric materials that are exposed to sunlight and are protected by glass, or other transparent medium, shall be tested with an equivalent layer of that medium attenuating the ultraviolet light exposure during the test.

Exception: Encapsulant materials between the substrate and the superstrate are not required to comply with the requirements of 7.2.

Table 7.1
Determination of comparative tracking index performance level category (PLC)

Voltage	Creepage distance	IPT 1 hr rating required	CTI PLC of 2 or better required
0 – 30	Any	No	No
> 30 – 600	< 12.7 mm	No	Yes
> 30 – 600	≥ 12.7 mm	No	No
> 600 – 1000	< 16.0 mm	Yes	No
> 600 – 1000	≥ 16.0 mm	No	No
1001 – 1500	< 24.0 mm	Yes	No
1001 – 1500	≥ 24.0 mm	No	No

Note – Voltage is determined as follows:

Between live parts: the maximum potential difference during normal use

Between live parts and dead metal parts that may be grounded in service: maximum system voltage

Between live parts and any surface exposed to contact: maximum system voltage

7.3 A polymeric substrate or superstrate shall have a thermal index (TI/RTE/RTI), both electrical and mechanical, as determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, or Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results, IEC 60216-1, not less than 90° C (194° F). In addition, the thermal index (TI/RTE/RTI) shall not be less than 20°C (36°F) above the measured operating temperature of the material. All other polymeric materials shall have a thermal index (TI/RTE/RTI) (electrical and mechanical) 20° C above the measured operating temperature. The measured operating temperature is the temperature measured during the open-circuit mode for Temperature Test, Section 19, or the temperature during the short-circuit mode, whichever is greater.

7.4 A polymeric material that serves as the outer enclosure for a module or panel that:

a) is intended to be installed in a multi-module or multi-panel system; or

b) has an exposed surface area greater than 10 ft^2 (0.93 m^2) or a single dimension larger than 6 ft (1.83 m)

shall have a flame spread index of 100 or less as determined under the Standard Method of Test for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162-2001.

Exception No. 1: A material that serves as the outer enclosure for a small cover or box used for electrical connections is not required to have an index of 100 or less.

Exception No. 2: A material that serves as the outer enclosure for a module or panel complying with 16.1 meets the intent of this requirement.

7.5 A barrier or liner of polymeric insulating material providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall be of adequate thickness and of a material appropriate for the application. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties may fall below the minimum acceptable values for the application.

8 Current-Carrying Parts and Internal Wiring

8.1 A current-carrying part and wiring shall have the mechanical strength and ampacity necessary for the service.

8.2 A current-carrying part shall be of silver, a copper-base alloy, stainless steel, aluminum, or other material appropriate for the application.

8.3 Wiring used in a module or panel shall be insulated and acceptable for the purpose, when considered with respect to temperature, voltage, and the conditions of service to which the wiring is likely to be subjected within the equipment.

8.4 A splice shall be provided with insulation equivalent to that required for the wires involved.

8.5 A joint or connection shall be mechanically secure and shall provide electrical contact without strain on connections and terminals. Soldered connections between interconnects and metallizations are considered mechanically secure when held by encapsulation systems.

8.6 An uninsulated live part, including a terminal, shall be secured to its supporting surface by a method other than friction between surfaces so that it will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than required in Table 12.1 and Table 12.2.

8.7 Strain relief shall be provided so that stress on a lead intended for field connection, or otherwise likely to be handled in the field, including a flexible cord, is not transmitted to the connection inside the module or panel.

8.8 The wiring of a module or panel shall be located so that after installation of the product in the intended manner it will not be exposed to the degrading effects of direct sunlight.

Exception: Wiring rated sunlight resistant need not be so located.

9 Wireways

9.1 An enclosure for wire shall be smooth and free from sharp edges, burrs, or the like that may damage insulation or conductors.

10 Connection Means

10.1 In 10.2 – 10.10, connection means are considered to be those to which field-installed wiring is connected when the product is installed. Connection means may be within a wiring compartment, may be connectors outside of a wiring compartment, or may be another means acceptable for the application.

10.2 A module or panel shall be capable of accommodating at least one of the acceptable wiring systems described in the National Electrical Code, NFPA 70.

10.3 A module or panel shall be provided with wiring terminals, connectors, or leads to accommodate current-carrying conductors of the load circuit.

10.4 The connection means for a module or panel shall be so located that after installation of the product in the intended manner they will not be exposed to the degrading effects of direct sunlight.

Exception: Connection means rated for use in direct sunlight need not be so located.

10.5 A lead that is intended to be spliced in the field to a circuit conductor shall not be smaller than 18 AWG (0.82 mm^2) and the insulation shall not be less than 1/32 in (0.8 mm) thick.

10.6 The free length of a lead for field connection shall be at least 6 in (152 mm).

10.7 A wire-binding screw or stud- and nut-type terminal used to terminate conductors not larger than 10 AWG (5.3 mm^2) shall comply with the following:

a) A threaded screw or stud shall be of nonferrous metal, stainless steel, or plated steel appropriate for the application, shall not have more than 32 threads/in, and shall not be smaller than No. 8 when used to terminate 10 or 12 AWG (5.3 or 3.3 mm^2) wire; and not smaller than No. 6 when used to terminate 14 AWG (2.1 mm^2) and smaller wire. A wire-binding screw or stud- and nut-type terminal shall be provided with upturned lugs, a cupped washer, a barrier, or other equivalent means to retain the wire in position. The head of a wire-binding screw used to terminate 12 AWG or smaller wire shall have a minimum diameter of 0.275 in (7.0 mm) and the head of a screw used to terminate 10 AWG wire shall have a minimum diameter of 0.327 in (8.3 mm).

b) A tapped terminal plate shall:

1) Be of nonferrous metal,

2) Not have less than two full screw threads, and

3) Be of metal not less than 0.050 in (1.27 mm) thick when used to terminate 10 or 12 AWG wire and not less than 0.030 in (0.76 mm) thick when used to terminate a 14 AWG or smaller wire. Unextruded metal for screw threads obtained by extruding a hole shall have a thickness not less than the pitch of the screw thread.

10.8 A connector intended for use on the output wiring of a module or panel shall comply with the Standard for Connectors for use in Photovoltaic Systems, UL 6703.

10.9 A separable multipole connector shall be polarized. If two or more separable connectors are provided, they shall be configured or arranged so that the mating connector for one will not be accepted by the other, and vice-versa, if such is an improper connection.

10.10 For a connector incorporating a grounding member, the grounding member shall be the first to make and the last to break contact with the mating connector.

11 Bonding and Grounding

11.1A **Grounding Terminology.** The term “grounding” encompasses two types of connection to Earth. One connection is a functional or system grounding where one of the circuit conductors (also known as a current-carrying conductor) is connected to a grounding system and then connected to earth. Functional grounding may or may not be implemented in any particular system. The second use of the grounding term refers to protective (earth) or equipment grounding where any exposed metallic conductive surfaces that may become energized (unintentionally) are connected to the grounding system and then connected to earth. The grounding system is composed of the grounding electrode (the actual connection to earth), and the grounding-electrode conductor (between the grounding electrode and a common grounding point). The common grounding point is where the functional/system-grounding conductor (if required) and the equipment/protective grounding conductor(s) (if required) connect to the grounding electrode conductor. The bonding and grounding material discussed in this section pertains only to equipment/protective grounding.

11.1B **Factory Bonding.** The process of bonding entails the electrical connection of the exposed conductive pieces of the module frame or other exposed conductive surfaces to create an equipotential

conductive surface. The bonding process is carried out in the factory under carefully controlled conditions using methods and hardware that must be identified and remain relatively controlled. These bonding methods and hardware are evaluated through the requirements in this standard. Changes in the hardware used in the bonding process must be revaluated through the tests described in this standard. The overall bonding connections are evaluated through the Bonding Path Resistance Test, Section 25.

11.1C **Field Grounding.** The process of grounding involves the connection of a field-installed conductor or assembly to the exposed conductive parts of a module that connects the exposed conductive parts of a module to earth in a manner prescribed by the National Electrical Code (NEC). The instruction manual provided with each PV module will describe the location and method of making this field installed connection. These connections will, in general, not be made under factory-controlled conditions nor will each and every field connection be evaluated by the Bonding Path Resistance Test, Section 25. Normally, the methods and hardware used to make electrical bonding connections in the factory will not be applicable to field installed grounding connections. Such hardware items may be used in making the grounding connections if, and only if, the hardware is supplied with the PV module and has been evaluated for use as a grounding device/method through the requirements in this standard. Only listed grounding devices may be used to ground PV modules.

11.1D **Insulating Coatings.** Clear coatings, anodizing, and the rapid oxidation of aluminum make electrical connections to module frames in the field difficult. In many cases, the clear coating, anodizing, and oxidation film will have to be penetrated or removed and an anti-oxidation compound applied to the bare aluminum surface before a good electrical connection can be made.

11.1 A module or panel shall have a means for grounding all accessible conductive parts. The grounding means shall comply with the applicable requirements in Connection Means, Section 10. The grounding means shall be bonded to each conductive part of the module or panel that is accessible during normal use. The grounding means shall be described in detail in the installation manual. See Installation and Assembly Instructions, Section 48.

Exception: When the grounding means is a module or panel mounting member intended to contact an array structural member, the module or panel grounding means are not required to comply with the requirements for Connection Means, Section 10.

11.2 Routine maintenance of a module or panel shall not involve breaking or disturbing the bonding path. A bolt, screw, or other part used for bonding purposes within a module or panel shall not be intended for securing the complete device to the supporting surface or frame.

11.3 Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connections, or welding, soldering (see 11.5) or brazing. The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel.

11.4 A bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead may be acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

11.5 All joints in the bonding path shall be mechanically secure independent of any soldering.

11.6 A separate bonding conductor or strap shall:

a) Be of copper, copper alloy, or other material acceptable for use as an electrical conductor;

b) Be protected from mechanical damage; and

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

11.7 A ferrous metal part in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings, such as painting, galvanizing, or plating. Stainless steel is acceptable without additional coating.

11.8 A metal-to-metal multiple-bearing pin-type hinge is considered to be an acceptable means for bonding.

11.9 A terminal of a module or panel (for example, a wire-binding screw, a pressure wire connector, or a nut-on-stud) intended to accommodate an equipment grounding conductor shall be identified by being marked "G," "GR," "GROUND," "GROUNDING," or the like, or shall have a green-colored part. No other terminal shall be so identified.

11.10 If a marking is used to identify an equipment grounding terminal, it shall be located on or adjacent to the terminal, or on a wiring diagram affixed to the module or panel near the terminal.

11.11 If a green-colored part is used to identify the equipment-grounding terminal, it shall be readily visible during and after installation of the equipment-grounding conductor and the portion of the terminal that is green shall not be readily removable from the remainder of the terminal.

11.12 The surface of a lead of a module or panel intended for the connection of an equipment-grounding conductor shall be identified by insulation colored green, or green with yellow stripe(s). No other lead shall be so identified.

12 Spacings

12.1 The spacings between uninsulated live parts not of the same potential and between a live part and an accessible metal part, shall not be less than the values specified in Table 12.1, Table 12.2, and Table 12.3.

Exception No. 1: These spacing requirements do not apply to the inherent spacings of a component; such spacings shall comply with the requirements for the component in question.

Exception No. 2: These distances do not apply to solid insulation materials when used as cemented joints, potting, encapsulant or conformal coating at the perimeter and at other locations with exposed edges of a module. Those insulation properties can be assessed through the tests outlined in the General Section 18, and Cemented Joints, Section 42A.

Exception No. 3: These distances do not apply to insulation materials when used as coatings at the interconnection of a module and a junction box. A coating intended to be used on a module to provide a Pollution Degree 1 shall comply with the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, Section 15, Printed Wiring Board Coating Performance Test.

NOTE 1: The minimum through material distance for solid insulation at the perimeter and at other locations with exposed edges of a module must be greater than or equal to the creepage distances defined in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, Table 9.1, using Pollution Degree 1.

NOTE 2: Minimum through distance for coatings at the interconnection of a module and a junction box must be greater than or equal to the creepage distances defined in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, Table 9.1, using Pollution Degree 1.

Table 12.1
Minimum acceptable spacings at wiring terminals

Potential involved, V	Through air and over surface	
	in	(mm)
0 – 50	1/4	(6.4)
51 – 300	3/8	(9.5)
301 – 600	1/2	(12.7)
601 – 1000	5/8	(15.9)
1001 – 1500	15/16	(24)

Table 12.2
Minimum acceptable spacings elsewhere than at wiring terminals

Potential involved, V	Through air		Over surface	
	in	(mm)	in	(mm)
0 – 50	1/16	(1.6)	1/16	(1.6)
51 – 300	1/8	(3.2)	1/4	(6.4)
301 – 600	1/4	(6.4)	3/8	(9.5)
601 – 1000	3/8	(9.5)	1/2	(12.7)
1001 – 1500 [a]	9/16	(14)	19/32	(15)

[a] For edge spacings (live parts to the accessible edge of the module) the values in Table 12.2 are for metallic framed modules. Double the over-surface and through-air distances for edge spacings of modules without metallic frames.

Table 12.3
Minimum acceptable spacings for creepage distances using Pollution Degree 1

Potential involved, V	Over surface	
	in	(mm)
600	0.066	(1.68)
1000	0.126	(3.20)
1500	0.205	(5.20)

Note: Distances for 600 V and 1500 V are based on linear interpolation of the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, Table 9.1, using Pollution Degree 1.

12.2 The spacings at a field-wiring terminal are to be measured with and without wire connected to the terminal. The wire is to be connected as it would be in actual use. If the terminal will properly accommodate it, and if the product is not marked to restrict its use, the wire is to be one size larger than that required; otherwise, the wire is to be the size required.

12.3 Surfaces separated by a gap of 0.013 in (0.33 mm) or less are considered to be in contact with each other for the purpose of judging over surface spacings.

12.4 In Table 12.1 and Table 12.2, the potential involved is the maximum voltage that may exist between parts during any anticipated use of the module or panel.

12.5 A barrier or liner of electrical grade fiber providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall not be less than