UL 1047

Underwriters Laboratories Inc.

Standard for Safety

Isolated Power Systems Equipment

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UL Standard for Safety for Isolated Power Systems Equipment, UL 1047

Fifth Edition, Dated October 7, 2010

SUMMARY OF TOPICS

The fifth edition of the Standard for Isolated Power Systems Equipment, UL 1047, has been issued to reflect the latest ANSI approval date, and to incorporate the following proposal:

> ***Revisions to Color-Code Requirements for Terminals or Leads to Which Isolated Output Conductors are Intended to be Field Connected and the Insulation on Internal Wires in Accordance with the National Electrical Code.***

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. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated January 30, 2009.

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Future Effective Date	References
Effective date to be determined	13.8 and 17.2

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UL 1047

Standard for Isolated Power Systems Equipment

First Edition – August, 1976
Second Edition – December, 1990
Third Edition – March, 1995
Fourth Edition – September, 2003

Fifth Edition

October 7, 2010

This ANSI/UL Standard for Safety consists of the Fifth Edition.

The most recent designation of ANSI/UL 1047 as an American National Standard (ANSI) occurred on October 7, 2010. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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CONTENTS

INTRODUCTION

1 Scope 5
2 Glossary 5
3 General 6
3.1 Components 6
3.2 Units of measurement 7
3.3 Undated reference 7

CONSTRUCTION

4 General 7
5 Enclosure 7
6 Ventilation 8
7 Connections for Wiring Systems 9
8 Corrosion Protection 9
9 Bases – Insulating Material 9
10 Mounting of Parts 10
11 Current-Carrying Parts 13
12 Permanently Connected Equipment 13
13 Field-Wiring Terminals and Leads 13
14 Cord-Connected Equipment 16
14.1 General 16
14.2 Strain relief 16
14.3 Bushings 17
15 X-Ray Equipment 17
16 Wall Modular Units 17
17 Internal Wiring 18
18 Separation of Circuits 19
18.1 Factory installed 19
18.2 Field-installed Class 2 19
19 Field-Wiring Space 20
19.1 General 20
19.2 Wire bending space 20
20 Spacings 23
21 Isolation Transformers 26
22 Line Isolation Monitor 28
23 Overcurrent Protection 28
24 Switches 29
25 Receptacles 29
26 Grounding Jacks and Cord Assemblies 30
27 Reference Grounding Bus 30

PERFORMANCE

28 Regulation 32
29 Temperature 33
30 Leakage Current 36
31 Dielectric Voltage-Withstand 44
32 Stability 45

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33 Strength of Insulating Base and Supports 45
34 Abnormal Operation 45
35 Push-Back Relief 46

MANUFACTURING AND PRODUCTION TESTS

36 Production-Line Dielectric Voltage-Withstand 46
37 Production-Line Grounding Continuity 48

RATING

38 Details 48

MARKING

39 Details 48

APPENDIX A

Standards for Components. A1

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INTRODUCTION

1 Scope

1.1 These requirements cover isolated power systems equipment rated 600 Vac or less, intended for installation and use in nonhazardous areas in health care facilities in accordance with the requirements in Article 517 of the National Electrical Code, NFPA 70, and in the Standard for Health Care Facilities, NFPA 99.

1.2 These requirements cover isolated power centers, either cord-connected or permanently wired, consisting of a distribution panel that incorporates an isolation transformer, one or more isolated ungrounded secondary circuits terminating in integrally mounted grounding-type receptacles, a reference grounding bus bar, and line isolation monitor. Isolated power centers may have provision for connection of grounding conductors to remote grounding jacks, the room bonding points, and patient equipment grounding points. A permanently wired isolated power center may also have provision for connection to remote receptacles or indicators.

1.3 These requirements cover convertible system units that facilitate a temporary conversion of the power supply for a power center from a grounded supply to an isolated supply.

1.4 These requirements cover isolated power panelboards that incorporate the same features as permanently wired isolated power centers except that:

a) They may be supplied from remote isolation transformers, and

b) The secondary isolated circuits are intended to be connected by conduit to remotely located receptacles.

1.5 These requirements cover wall modular units containing isolated power systems.

1.6 These requirements cover cord-connected isolated power centers, and panels intended to supply x-ray equipment only.

2 Glossary

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

2.2 CONVERTIBLE-SYSTEM UNIT – An enclosed assembly incorporating an isolation transformer and line isolation monitor with interconnecting cord assemblies that facilitate temporary conversion of the power supply for a power center from a grounded supply to an isolated supply. The unit is intended for use only with the specific power centers for which it has been designed.

2.3 FIELD-WIRING TERMINAL – A terminal to which a supply or other wire can be connected by an installer in the field is a field-wiring terminal unless a lead is provided as part of a pressure terminal connector, or other means for making the connection is factory-assembled to the wire.

2.4 LINE ISOLATION MONITOR – A test instrument designed to continually check the balanced and unbalanced impedance from each line of an isolated circuit to ground and equipped with a built-in test circuit to actuate an alarm without adding to the leakage current.

2.5 MOMENTARY RATING – A rating based on an operating interval that does not exceed 5 s.

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2.6 PATIENT EQUIPMENT GROUNDING POINT – A jack or terminal bus that serves as the collection point for redundant grounding of electric appliances serving a patient vicinity or for grounding other items in order to eliminate electromagnetic interference problems.

2.7 REFERENCE GROUNDING POINT – A terminal bus that is an extension of the equipment grounding bus and is a convenient collection point for grounding all electric appliances, equipment, and exposed conductive surfaces in a patient vicinity.

2.8 ROOM BONDING POINT – A grounding terminal bus that serves as the collection point for grounding exposed metal or conductive building surfaces in a room.

2.9 WALL MODULAR UNIT – A factory-built wall section or sections typically containing various combinations of gas outlets, lighting fixtures, clocks, intercommunication units, and the like for use in, within, or as part of health-care facilities. Only units containing isolated power systems equipment are covered by this standard. Grounded power circuits that are physically segregated and separated may also be included.

3 General

3.1 Components

3.1.1 Except as indicated in 3.1.2, 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.

3.1.2 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.

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

3.1.4 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.

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3.2 Units of measurement

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

3.3 Undated reference

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

CONSTRUCTION

4 General

4.1 Isolated power systems equipment shall employ materials throughout that are acceptable for the application, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

4.2 A convertible system unit shall be designed to convert a specific power center from a grounded supply to an isolated supply. The specific power center shall consist of overcurrent protection devices, receptacles, grounding jacks and components other than the transformer and line isolation monitor that have been previously permanently installed. Also the grounding conductor from the grounded supply to the distribution panel or modular wall section shall remain continuous and so arranged that it is not interrupted by the converting procedure.

4.3 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to cause a risk of injury in normal maintenance or use.

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

5 Enclosure

5.1 The enclosure of isolated power systems equipment shall comply with the Standard for Enclosures for Electrical Equipment, UL 50.

Exception: An enclosure may be ventilated in accordance with Ventilation, Section 6.

5.2 An enclosure cover or door shall be hinged, sliding, or similarly attached so that it cannot be wholly detached without the use of a tool, if it gives access to a fuse or any other overload-protective device the normal functioning of which requires renewal, or if it is necessary to open the cover during normal operation of the device.

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6 Ventilation

6.1 A ventilating opening in an enclosure shall be constructed and located so that no flame or molten metal will be emitted during the arcing encountered during the operation of fuses, switches, or circuit breakers.

6.2 Unless the opening is remote from the arcing part, the requirement in 6.1 necessitates the interposing of a noncombustible barrier between a ventilating opening and a possible source of arcing such as a switch, fuse, and the like.

6.3 The barrier shall be of such dimensions and located so that straight lines drawn from any arcing part past the edge of the barrier will define an area at the plane of the opening 1/4 in (6.4 mm) beyond the edges of the opening.

6.4 A sheet-steel barrier shall not be less than 0.053 in (1.35 mm) thick if uncoated and not less than 0.056 in (1.42 mm) thick if galvanized.

Exception: A steel barrier may be of lesser thickness provided its strength and rigidity is not less than that of a flat sheet of steel of the specified thickness having the same dimensions as the barrier.

6.5 The thickness of a nonmetallic barrier may be less than 1/4 in (6.4 mm) if the barrier is located so that it will not be subject to mechanical abuse during installation and is located and supported so that it will have the necessary mechanical strength and rigidity.

6.6 A ventilating opening in an enclosure shall have such size or shape, or shall be covered by screening or by an expanded, perforated, or louvered metal panel so that a test rod of the diameter specified in 6.7 will not enter the opening.

6.7 The test rod mentioned in 6.6 shall be 33/64 inch (13.2 mm) in diameter if the plane of the opening is less than 4 in (102 mm) from an uninsulated live part, or 49/64 inch (19.4 mm) in diameter if the plane of the opening is 4 in or more from such part.

6.8 The size, shape, and location of a screened opening shall be such as not to unduly weaken the overall enclosure.

6.9 The area of a ventilating opening in an enclosure shall not exceed 80 in^2.

6.10 The wires of a screen required to protect a ventilating opening shall not be smaller than 16 AWG (1.3 mm^2) if the screen openings are 1/2 in^2 or less in area, and not smaller than 12 AWG (3.3 mm^2) for larger screen openings. A supplementary screen of smaller openings may be additionally provided. The supplementary screen is not to be considered in the evaluation of the ventilating opening screen.

6.11 Perforated sheet steel and sheet steel employed for expanded-metal mesh shall not be less than 0.042 in (1.07 mm) thick if uncoated, or 0.045 in (1.14 mm) if galvanized if the mesh openings or perforations are 1/2 in^2 or less in area, and shall not be less than 0.080 in (2.03 mm) thick if uncoated, or 0.084 in (2.13 mm) thick if galvanized for larger openings.

Exception: Where the indentation of a guard or enclosure cannot alter the clearance between uninsulated live parts and grounded metal so as to affect performance adversely or reduce spacings below the minimum values given in Table 20.1, perforated sheet steel and sheet steel employed as expanded metal-mesh not less than 0.020 in (0.51 mm) thick if uncoated, or if galvanized 0.023 in (0.58 mm) thick may be used.

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6.12 A grill construction complying with the intent of the requirements in 6.11 may be accepted if it has been found to be suitable for the particular application.

6.13 The length of ventilating louvers in an enclosure shall not exceed 12 in (305 mm).

6.14 A separate louvered panel that is riveted or welded in place over a ventilating opening in the enclosure may be of not less than 0.032 in (0.81 mm) thick if uncoated and not less than 0.034 in (0.86 mm) thick if galvanized sheet steel.

6.15 A ventilating opening in the top of the enclosure shall be covered by a hood or protective shield spaced above the opening to prevent the entry of foreign material.

7 Connections for Wiring Systems

7.1 Knockouts provided in the enclosure shall be of the proper size; and shall be so located that the installation of bushings will not result in spacings between live parts and bushings of less than the minimum requirements specified in Table 20.1. At least two of the knockouts shall be sized to accommodate the largest size wiring which could be used in the installation of the panel.

8 Corrosion Protection

8.1 Iron and steel parts shall be suitably protected against corrosion by enameling, galvanizing, sherardizing, plating or other equivalent means.

8.2 The requirement of 8.1 applies to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to bearings, laminations, and the like, if the failure of such unprotected parts would not be likely to result in a hazardous condition or in the equipment's operation being affected adversely. Parts made of stainless steel of the type having inherent resistance to corrosion (properly polished or treated, if necessary) do not require additional protection against corrosion. Bearing surfaces should be of such materials and design to ensure against binding due to corrosion.

9 Bases – Insulating Material

9.1 A base for mounting uninsulated live parts shall be strong, not easily ignited, moisture-resistant and insulating. The base shall be of such material that it will withstand the most severe conditions likely to be met in service.

9.2 Ordinary fiber, rubber, and so-called hot-molded shellac and tar compositions are not acceptable for the mounting of uninsulated live metal.

9.3 Insulating material including barriers between parts of opposite polarity and material that may be subject to the influence of the arc formed by the opening of contacts shall be suitable for the particular application.

9.4 A live screw head or nut on the underside of an insulating base shall be reliably prevented from loosening and shall be adequately insulated or spaced from the mounting surface. This may be accomplished by:

a) Countersinking such parts not less than 1/8 inch (3.2 mm) in the clear and then covering them with a waterproof, insulating sealing compound that does not soften at a temperature 15°C (27°F) higher than its normal operating temperature in the device, and not less than 90°C (194°F) in any case; or

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b) Reliably securing such parts and insulating them from the mounting surface by means of a barrier, or the equivalent, or by means of through-air or over-surface spacings not less than the minimum values specified in Table 20.1.

9.5 With reference to 9.4, a lock washer, properly applied, is acceptable as a means of preventing the loosening of a screw or nut.

9.6 With reference to 9.4(a), determination of the softening point of a sealing compound is to be made in accordance with the American Society for Testing and Materials Standard Test for Softening Point by Ring and Ball Apparatus, ASTM E28-1967.

10 Mounting of Parts

10.1 All parts shall be securely mounted in position and prevented from loosening or turning if such motion may affect adversely the normal performance of the equipment, or may increase the risk of fire, shock, and injury to persons incident to the operation of the equipment.

10.2 Uninsulated live metal parts shall be secured to their supporting surfaces so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings to less than those indicated in Table 20.1. The security of contact assemblies shall be such as to ensure the continued alignment of contacts. See also 13.9.

10.3 With reference to 10.1 and 10.2, friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part; but a suitable lock washer, properly applied, may be accepted.

10.4 The wiring of an electrical component mounted on a door or hinged cover shall be factory installed using suitable pressure wire connectors, at each end, that comply with the Standard for Wire Connectors, UL 486A-486B. There shall be no provision for connection of field wiring.

Exception No. 1: Quick-connect terminals may be used for signal lights, buzzers or switches, if clamps or the equivalent are provided where necessary to prevent stress on the terminations.

Exception No. 2: Provision may be made for field-installation of clocks, timers, or lighting fixtures by means of plugs and receptacles.

10.5 Wires connected to a component mounted on a door or hinged cover shall:

a) Not be larger than 12 AWG (3.3 mm^2),

b) Be stranded,

c) Have at least 1/32 in (0.79 mm) thick insulation, and

d) Be cabled or routed so as to avoid being damaged during opening and closing of the door or hinged cover.

Exception No. 1: A bundle or cable of not more than 12 wires, in addition to the bonding wire mentioned in 10.6, may contain 10 AWG (5.3 mm^2) wires.

Exception No. 2: A bundle or cable of not more than 4 wires, in addition to the bonding wire mentioned in 10.6, may contain 10 AWG wires.

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10.6 A door or hinged cover on which electrical components are mounted shall be bonded to the box with a wire not smaller than 10 AWG (5.3 mm^2).

10.7 Electrical parts of a component mounted on a cover shall be located or enclosed so that with the cover open, persons are protected against unintentional contact with uninsulated live parts.

Exception: Live parts may be accessible if the voltage involved is 42.4 V peak or less or if the available current measured through a 1500 Ω noninductive resistor is 0.5 mA or less.

10.8 Not more than six receptacles and six grounding jacks shall be mounted on a single cover of a remote assembly.

10.9 Receptacles and grounding jacks mounted on a cover of a remote assembly shall be factory wired to pressure wire terminals in the remote assembly box.

Exception No. 1: Factory wiring is not required if:

a) Not more than six devices (receptacles, grounding jacks and signal lights) are provided,

b) The field installed wires do not exceed six 12 AWG (3.3 mm^2) plus one grounding conductor,

c) It is not necessary to remove the devices from the cover in order to do the wiring, and

d) The assembly is not intended for wiring other than that associated with the receptacles and jacks.

Exception No. 2: A single grounding wire may be field wired if no reference grounding bus is provided in the remote assembly box.

10.10 Factory wiring of receptacles and grounding jacks mounted on a cover of a remote assembly shall be stranded and shall have at least 1/32-in (0.79-mm) thick insulation.

10.11 The enclosure of a remote assembly shall have a depth that accommodates the reinstallation of the cover after wiring is completed without forcing conductors against parts mounted on the cover. Parts mounted in the box such as wire terminating means shall be located so that wires connected to parts on the cover are not forced against such parts after the cover is reinstalled.

10.12 The cover of a remote assembly that is intended to be field wired shall have suitable means for its support during field wiring so that the cover assembly does not hang completely on the connected wires. This may be accomplished by the use of hinges, by instructions and design to permit hanging the cover from the lower box cover screws, or the equivalent.

10.13 If parts are held together by screws, a metal threaded part shall have no fewer than two full, clean-cut threads engaged. If the screw does not extend all the way through a threaded part, the taper or lead and the first full thread are to be disregarded in a determination of the number of threads engaged.

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10.14 The transformer may be shipped separately from the equipment providing:

a) The equipment is marked to identify the transformer and the location where it is to be mounted;

b) All wiring in the equipment is provided necessitating only the line, load and grounding connections as required, to the transformer to be made; and

c) All necessary mounting hardware is provided on the equipment.

10.15 A power center interior or a panelboard interior may be shipped separately from its enclosure providing:

a) The enclosure, interior, and transformer when required, are marked to indicate units that are to be used together;

b) The equipment is marked with instructions for proper field-installation and wiring;

c) The interior is capable of being installed without removing or displacing enclosure parts other than a cover;

d) All wiring is provided necessitating field connections only:

1) To line, load, and ground,

2) Between transformer primary and the main switch or circuit breaker, when provided,

3) Between transformer secondary and interior,

4) Between the reference ground bus and the enclosure, and

5) Between the transformer core and the reference ground bus of the enclosure;

e) All necessary mounting hardware is provided on the equipment;

f) The necessary wiring connections and routing of wiring complies with the requirements in Separation of Circuits, Section 18; and

g) All wiring has been precabled so as to reduce the likelihood of damage, and strain relief is provided to prevent stress from being transmitted to the wiring connections.

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11 Current-Carrying Parts

11.1 A current-carrying part shall have mechanical strength and ampacity necessary for the service, and shall be of metal that is acceptable for the application.

12 Permanently Connected Equipment

12.1 Permanently-connected isolated power systems equipment shall have provision for the connection of a wiring system.

Exception: Permanently connected equipment may be acceptable without provision for the connection of a wiring system if instructions indicating the locations that are intended to be drilled in the field for the connection of raceways are included with the equipment.

13 Field-Wiring Terminals and Leads

13.1 Permanently connected equipment shall be provided with wiring terminals or leads for the connection of all field-installed conductors. Wiring terminals shall be acceptable for use with conductors having an ampacity not less than the ampere rating of the equipment.

13.2 With reference to 13.1, sizes of field-installed conductors corresponding to a specific ampacity rating shall be determined according to Table 13.1, based on the following:

a) The use of:

1) Wire rated 75°C (167°F) for 1/0 AWG (53.5 mm^2) and larger.

2) Wire rated 60°C (140°F) for 1 AWG (42.4 mm^2) and smaller, except 75°C (167°F) wire if the equipment is marked for use with 75°C wire in accordance with 39.28.

b) The use of aluminum wire at any terminal indicated on a wiring diagram or the like as being acceptable for use with such wire, whether or not that terminal is also indicated as being acceptable for use with copper wire. See 39.10 – 39.19.

13.3 A wiring terminal shall be capable of holding the next larger size conductor than that required by 13.1 if the terminal will properly receive the larger size conductor, unless the equipment is marked to restrict its use to the smaller size conductor.

13.4 Pressure wire connectors shall be employed for 8 AWG (8.4 mm^2) and larger conductors. For 10 AWG (5.3 mm^2) and smaller wires, the parts to which wiring connections are made may consist of binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position.

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Table 13.1
Ampacity of insulated conductors

Wire size		Ampacity			
		60°C (140°F)		75°C (167°F)	
AWG or kcmil	(mm^2)	Copper	Aluminum	Copper	Aluminum
14	(2.1)	15	–	15	–
12	(3.3)	20	15	20	15
10	(5.3)	30	25	30	25
8	(8.4)	40	30	50	40
6	(13.3)	55	40	65	50
4	(21.2)	70	55	85	65
3	(26.7)	85	65	100	75
2	(33.6)	95	75	115	90
1	(42.4)	110	85	130	100
1/0	(53.5)	–	–	150	120
2/0	(67.4)	–	–	175	135
3/0	(85.0)	–	–	200	155
4/0	(107.2)	–	–	230	180
250	(127)	–	–	255	205
300	(152)	–	–	285	230

NOTE – These values of ampacity apply only where a maximum of three current-carrying conductors are to be field installed in a single conduit. When four or more conductors other than a grounding conductor or a neutral that carries the unbalanced current are to be installed in a conduit, the ampacity of each of these conductors is to be reduced as shown in the following table. These reduced values do not apply to internal wiring unless it is enclosed in conduit.

Number of conductors	Percent of value in table
4 – 6	80
7 – 24	70
25 – 42	60
43 or more	50

13.5 If a wire-binding screw is employed the screw shall not be smaller than No. 10.

Exception: A No. 8 or 6 screw may be used for the connection of a 14 AWG (2.1 mm^2) or smaller remote indicator or control-circuit conductor.

13.6 A wire-binding screw shall thread into metal, and shall not have less than two full threads.

13.7 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 in (1.27 mm) thick.

Exception No. 1: A plate not less than 0.030 in (0.76 mm) thick is acceptable if the metal is extruded at the tapped hole so as to provide two full threads.

Exception No. 2: Other constructions may be employed if they provided equivalent strength of the terminal plate and thread security of the wire-binding screw.

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