

UL 1010

ISBN 0-7629-1242-1

Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations, UL 1010

Seventh Edition, Dated December 1, 2006

Summary of Topics

This new edition of UL 1010 is being issued through UL's electronic publishing system to ensure format uniformity between the PDF and HTML versions of the document. While numbering and figure placement, where appropriate, may have been updated, no substantive changes have been incorporated in the document. This new edition also incorporates deleting reference to ANSI approval.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

UL's Standards for Safety are copyrighted by UL. Neither a printed copy of a Standard, nor the distribution diskette for a Standard-on-Diskette and the file for the Standard on the distribution diskette should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

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

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Classification, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

Copyright © 2006 Underwriters Laboratories Inc.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-60	December 1, 2006
SA1-SA8	December 1, 2006

DECEMBER 1, 2006

1

UL 1010

**Standard for Receptacle-Plug Combinations For Use In Hazardous
(Classified) Locations**

The First through Third editions were titled Receptacle-Plug Combinations for Use in Hazardous Locations.

First Edition – February, 1972
Second Edition – March, 1973
Third Edition – December, 1977
Fourth Edition – February, 1986
Fifth Edition – February, 1991
Sixth Edition – June, 1995

Seventh Edition

December 1, 2006

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. 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>.

ISBN 0-7629-1242-1

COPYRIGHT © 2006 UNDERWRITERS LABORATORIES INC.

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope	6
2 General	6
2.1 Units of measurement	6
2.2 Undated references	7
2.3 Components	7
3 Class I, Zone, and Group Equivalency	7
3.1 Class I, Zone 1, Group IIA	7
3.2 Class I, Zone 1, Group IIB	7
3.3 Class I, Zone 1, Group IIB plus Hydrogen	8
3.4 Class I, Zone 1, Group IIC	8

CONSTRUCTION

PLUG AND RECEPTACLE

4 General	8
5 Materials	8
6 Live Parts	9
7 Grounding	9
8 Supply Connections	10
8.1 Receptacle	10
8.2 Plug	10
8.3 Plug and receptacle	10
9 Receptacle Employing Interlocking Switch or Circuit Breaker	13
10 Contact and Blade Exposure	13
11 Spacings	16
12 Assembly	17
13 Materials Applied to Joint Surfaces	18
14 Protection Against Corrosion	18
15 Raintight Enclosure	19

PLUG

16 General	19
17 Enclosure	19
18 Strain Relief	20
19 Bushings	20

RECEPTACLE

20 General	20
21 Enclosure	20
21.1 Material	20
21.2 Strength	22
22 Seal Between Electrical Enclosure and Receptacle Contacts	22
23 Joints in Enclosure	22
23.1 General	22
23.2 Class I, Groups C and D locations	23

23.3 Class I, Group B Locations	28
23.4 Class I, Group A locations	29
23.5 Class II, Group F and G locations	29
24 Shaft Openings	30
24.1 General	30
24.2 Receptacle enclosure for Class I locations	30
24.3 Receptacle enclosure for Class II locations	30
25 Supply Connections	31
25.1 Enclosure for Class I locations	31
25.2 Enclosure for Class II locations	33
26 Bonding	34
27 Drain and Breather Plugs in Enclosure	34
28 Holes in Enclosure	35
28.1 Class I locations	35
28.2 Class II locations	35

PLUG AND RECEPTACLE FOR FLAMMABLE ANESTHETIZING LOCATIONS

29 General	36
------------------	----

PERFORMANCE

30 General	39
31 Overload Test	39
32 Normal Temperature Test	41
33 Exposed Surface Temperature Test	43
34 Strain-Relief Test	44
35 No-Load Endurance Test	44
36 Full-Load Endurance Test	45
37 Test for Arc-Sustaining in the Presence of Explosive Atmospheres	45
38 Overload Test in the Presence of Explosive Atmospheres	46
39 Test for Arcing in the Presence of Grain Dust-Air Atmospheres	47
40 Explosion Tests	47
40.1 General	47
40.2 Terminal Box	48
40.3 Circuit breaker enclosure	49
40.4 Switch enclosure	50
41 Hydrostatic Pressure Test	50
42 Dust Penetration Test	50
43 Test for Secureness of Conduit Hubs	51
43.1 General	51
43.2 Pullout	51
43.3 Bending	51
44 Rain Test	53
45 Accelerated Aging of Gaskets Test	56
46 Watertightness Test	56

RATING

47 General	56
------------------	----

MARKING

48 General	57
------------------	----

SUPPLEMENT SA - TESTS ON POLYMERIC ENCLOSURES AND SEALING COMPOUNDS**GENERAL**

SA1 Scope	SA1
-----------------	-----

PART I – TESTS ON ENCLOSURES FOR CLASS I RECEPTACLES AND PLUGS

SA2 General	SA1
SA3 Explosion Tests	SA1
SA4 Hydrostatic Pressure Test	SA2
SA5 Chemical-Resistance Tests	SA2
SA6 Accelerated Air-Oven Aging Test	SA4
SA7 Test for Accumulation of Static Electricity	SA5
SA8 Resistance to Fungus Test	SA5
SA9 Resistance to Ultraviolet (UV) Light and Water	SA6

PART II – TESTS ON ENCLOSURES FOR CLASS II RECEPTACLES AND PLUGS

SA10 General	SA7
--------------------	-----

PART III – TESTS ON SEALING COMPOUNDS

SA11 General	SA7
--------------------	-----

INTRODUCTION

1 Scope

1.1 These requirements cover receptacles with plugs, receptacles with plugs interlocked with circuit breakers, and receptacles with plugs interlocked with switches, for installation and use in hazardous (classified) locations, Class I, Division 1, Groups A, B, C, and D, and Class II, Division 1, Groups F and G in accordance with the National Electrical Code NFPA 70.

1.2 These requirements also cover explosion-proof electrical equipment for installation and use in Class I, Zone 1, Groups IIA, IIB, IIB plus Hydrogen, and IIC hazardous (classified) locations.

1.3 These requirements cover devices rated not more than 200 amperes, not more than 600 volts, alternating-current (ac), and not more than 250 volts, direct-current (dc).

1.4 These requirements cover receptacle-plug combinations for use only under the following atmospheric conditions:

- a) A minimum ambient temperature of minus 25°C (minus 13°F),
- b) An oxygen concentration not greater than 21 percent by volume, and
- c) A nominal barometric pressure of one atmosphere.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Units of measurement

2.1.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.2 Undated references

2.2.1 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.

2.3 Components

2.3.1 Except as indicated in 2.3.2, a component of a product covered by this standard shall comply with the requirements for that component.

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

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

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

2.3.4 Specific components are recognized as being 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 for which they have been recognized.

3 Class I, Zone, and Group Equivalency

3.1 Class I, Zone 1, Group IIA

3.1.1 Explosion-proof electrical equipment intended to be marked in accordance with 48.2 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group D hazardous (classified) locations.

3.2 Class I, Zone 1, Group IIB

3.2.1 Explosion-proof electrical equipment intended to be marked in accordance with 48.3 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group C hazardous (classified) locations.

3.3 Class I, Zone 1, Group IIB plus Hydrogen

3.3.1 Explosion-proof electrical equipment intended to be marked in accordance with 48.4 shall comply with all the requirements for explosion-proof electrical equipment for use in Class I, Group B hazardous (classified) locations.

3.4 Class I, Zone 1, Group IIC

3.4.1 Explosion-proof electrical equipment intended to be marked in accordance with 48.5 shall comply with all the requirements for explosion-proof electrical equipment for use in both Class I, Group A and Class I, Group B hazardous (classified) locations.

CONSTRUCTION

PLUG AND RECEPTACLE

4 General

4.1 Where reference is made to contact blades, the requirements also apply to flat, round, butt type, and similar contacts.

5 Materials

5.1 A base or body in or on which live parts are mounted shall be of porcelain, phenolic, urea, or cold-molded composition or of equivalent insulating material.

5.2 Among the factors that are to be taken into consideration when determining the acceptability of a nonmetallic material are resistance to:

- a) Mechanical damage,
- b) Impact,
- c) Moisture-absorption,
- d) Combustibility,
- e) Solvents as covered by the hazardous location group or groups under consideration,
- f) Accumulations of electrostatic charges,
- g) Distortion and creep at temperatures to which the material may be subjected under all conditions of use,
- h) Fungus, and
- i) Repeated explosions.

All of these factors are to be considered with respect to thermal aging.

5.3 Except for a raintight device, vulcanized fiber may be used for insulating washers, separators, and barriers, but shall not be used as the sole support for live parts. Hard rubber is not acceptable.

5.4 An iron or steel part, other than a stainless steel part, shall be protected against corrosion.

6 Live Parts

6.1 Iron or steel, plain or plated, shall not be used for a part that is depended upon to carry current or for a wire-binding nut or screw.

Exception: Stainless steel may be employed for a part not subject to arcing, if found to be acceptable.

6.2 A current-carrying part shall be prevented from turning relative to the surface on which it is mounted if turning would impair the performance of the device.

6.3 An uninsulated live part shall be secured in place to prevent a reduction in the spacings to less than those required by 11.1.

7 Grounding

7.1 Except as indicated in 7.2, a receptacle and a plug shall have a separate contact and a blade, respectively, for interconnection of the equipment-grounding conductor.

7.2 The metal shell of a plug may be used as the grounding-contact member if:

- a) The part of the plug shell that is depended upon for grounding continuity is unlikely to be painted or otherwise subjected to conditions that may result in loss of grounding continuity;
- b) At least two separate grounding contact points are provided in the receptacle; and
- c) The receptacle grounding contact points are protected against damage.

7.3 Unless the plug and the receptacle are of the interlocked type that requires disconnection of the supply circuit before the plug can be inserted or removed, the grounding contact in the receptacle shall be located and formed so that electrical continuity to the grounding blade or contact of the mating plug is completed before continuity is established between any other contact and its respective blade on the plug. This grounding path shall be substantial when the plug is seated in the receptacle as intended.

7.4 The grounding-contact path, other than the metal housing, shall be of copper or of a copper-base alloy. The contact surfaces in the grounding contact path may be of silver, silver alloy, or other equivalent material. Also see 7.5.

7.5 A rivet, bolt, or clamp that is used to secure parts in the grounding path, but that is not an essential conductor in the grounding path, may be of steel or of another acceptable material.

7.6 A copper-base-alloy rivet that is used to hold parts in the grounding-contact path together or that forms a part of the grounding path shall contain not less than 80 percent copper.

7.7 A connection in the grounding-contact path shall be secured by riveting, bolting, welding, or equivalent means.

7.8 All dead metal parts of a receptacle that could become energized shall be conductively connected to the point of attachment of the equipment grounding conductor.

7.9 All dead metal parts of a plug enclosure that could become energized shall be conductively connected to the point of attachment of the equipment grounding conductor when the plug is inserted in the receptacle.

8 Supply Connections

8.1 Receptacle

8.1.1 A receptacle shall have provision for the connection of a wiring system.

8.1.2 The location of a terminal box or a compartment in which power-supply connections to the receptacle are to be made shall be such that the connections may be readily inspected after the device is installed as intended without the disconnection of any portion of the wiring.

8.1.3 A terminal compartment intended for the connection of a supply raceway shall be such that movement is prevented in relation to the complete receptacle assembly.

8.2 Plug

8.2.1 A plug shall have provision for connection of extra-hard usage Type S, SO, ST, or STO flexible cord with grounding conductor. Except for a flammable anesthetizing location plug of the construction covered in 29.1 – 29.8, the terminal enclosure shall be of a construction that will allow the cord to be readily replaced when necessary.

8.3 Plug and receptacle

8.3.1 General

8.3.1.1 A receptacle and a plug shall be provided with acceptable field-wiring terminals or leads for the connection of conductors having an ampacity, in accordance with the National Electrical Code, ANSI/NFPA 70-1993, not less than the current rating of the mating parts.

8.3.1.2 For the purpose of these requirements, field-wiring terminals are considered to be the terminals to which power-supply, control, or equipment-grounding connections will be made in the field when the device is installed. It is assumed that 60°C (140°F) wire will be used for connections to a device rated at 80 amperes or less and that 75°C (167°F) wire will be used with a device rated at more than 80 amperes.

8.3.2 Terminals

8.3.2.1 The wiring terminals of a receptacle shall be located or protected so that live parts will not be forced against the wiring in the terminal box or compartment during installation.

8.3.2.2 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable for the application, in accordance with the National Electrical Code, ANSI/NFPA 70-1993. Connections that depend upon solder shall not be used.

8.3.2.3 Other than as indicated in 8.3.2.2, 8.3.2.4, and 8.3.2.6, a field-wiring terminal on a receptacle shall be provided with a soldering lug or well or with a pressure wire connector securely fastened in place; for example, firmly bolted or held by a screw.

8.3.2.4 A wire-binding screw may be employed at a field-wiring terminal on a receptacle intended to accommodate a No. 10 AWG (5.3 mm²) stranded or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position. See also 8.3.2.9.

8.3.2.5 Other than as indicated in 8.3.2.2, the terminals employed on a plug shall be provided with an acceptable soldering lug or well or with a pressure wire connector of the type by which the wire is clamped between two plates.

8.3.2.6 Other forms of construction may be accepted if the ampacity and mechanical features are found to be equivalent to those of one of the connections described in 8.3.2.3 – 8.3.2.5.

8.3.2.7 A field-wiring terminal shall be prevented from any turning or shifting in position that may impair the assembly by means other than friction between surfaces. This may be accomplished by:

- a) Screws or rivets;
- b) Square shoulders or mortices;
- c) A dowel pin, lug, or offset;
- d) A connecting strap or clip fitted into an adjacent part; or
- e) Some other equivalent method.

8.3.2.8 The requirement specified in 8.3.2.7 does not preclude a limited degree of movement so that the blades and contacts of the mating plug and receptacle may be somewhat self-aligning.

8.3.2.9 A wire-binding screw at a field-wiring terminal shall not be smaller than No. 10 (4.8 mm), except that a No. 8 (4.2 mm) screw may be used at a terminal intended only for the connection of a No. 12 or 14 AWG (3.3 or 2.1 mm²) conductor.

8.3.2.10 In accordance with the National Electrical Code, ANSI/NFPA 70-1993, No. 14 AWG (2.1 mm²) is the smallest conductor which may be used for branch-circuit wiring, and thus is the smallest conductor that may be anticipated at a terminal for the connection of a power-supply wire.

8.3.2.11 A terminal plate tapped for a wire-binding screw shall be metal not less than 0.050 inch (1.27 mm) thick, except that a plate not less than 0.030 inch (0.76 mm) thick is acceptable if the tapped threads have the necessary mechanical strength. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

8.3.2.12 An upturned lug or a cupped washer shall retain a conductor of the size mentioned either in 8.3.1.1 [but not smaller than No. 14 AWG (2.1 mm²)] or in 8.3.2.4, whichever is applicable, under the head of the screw or the washer.

8.3.2.13 A wire-binding screw shall thread into metal.

8.3.2.14 A field-wiring terminal intended for the connection of a grounded conductor shall be of, or plated with, a metal substantially white in color (such as nickel) and shall be distinguishable from the other terminals, or identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

Exception: This requirement does not apply to a receptacle for anesthetizing locations.

8.3.2.15 A white head of a wire-binding screw that is not removable from its terminal plate and that does not clearly relate to the improper slot or blade in the device configuration may serve as the terminal identification specified by 8.3.2.14.

8.3.2.16 A white terminal plate of a binding-screw terminal that is plainly visible after wiring and that does not clearly relate to the improper slot or blade in the device configuration may serve as the terminal identification specified in 8.3.2.14 if all of the line terminal binding screws are of the same color.

Exception: This requirement does not apply to a receptacle for anesthetizing locations.

8.3.2.17 Other than when a device is constructed so that the factory installed bond between the terminal and exposed dead metal parts is readily visible and the terminal for the connection of the grounding conductor is obvious, the terminal for the connection of an equipment-grounding conductor shall have a permanent identification that is readily identifiable during installation. The terminal marking shall be one of the following:

- a) A terminal screw that is not readily removable and that has a green-colored head that is hexagonal, slotted, or both;
- b) A hexagonal green-colored nut that is not readily removable from a threaded terminal stud;
- c) A visible pressure wire connector that has a green-colored body or appendage that is not readily removable from the connector; or
- d) A concealed pressure wire connector identified as specified in 8.3.2.18.

8.3.2.18 If a pressure wire connector at the equipment-grounding terminal is located within the insulating body and is not readily visible, the wire-entrance hole for a connection to that terminal shall be identified by one of the following:

- a) A distinct green-colored area immediately adjacent to the wire-entrance hole; or
- b) The letter or word "G," "GR," "GND," "Ground," "Grounding," or "Green" distinctively marked immediately adjacent to the wire-entrance hole in letters at least 1/16 inch (1.6 mm) high.

8.3.2.19 A readily removable – not staked or otherwise held captive – part of an equipment-grounding terminal, such as a setscrew or a clamping member, shall not be colored green or otherwise identified as part of the grounding terminal if the part may be interchanged with a similar part of another terminal on the device.

8.3.3 Leads

8.3.3.1 A lead intended for the connection of a grounded conductor shall be finished to show a white or natural grey color and shall be distinguishable from the other leads.

Exception: This requirement does not apply to a receptacle for anesthetizing locations.

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

8.3.3.3 The requirements specified in 8.3.3.1 and 8.3.3.2 relating to color coding of a lead for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

8.3.3.4 The free length of a lead inside an outlet box or wiring compartment shall be 4 inches (102 mm) or more if the lead is intended for field connection to an external circuit. The length of a grounding lead if provided shall not be less than 6 inches (152 mm).

9 Receptacle Employing Interlocking Switch or Circuit Breaker

9.1 An interlocking switch or circuit breaker employed in a receptacle-plug combination so that the plug cannot be withdrawn or inserted when the switch or circuit breaker is in the on position shall simultaneously break all current-carrying conductors, including the neutral conductor (if any), of the supply circuit.

10 Contact and Blade Exposure

10.1 A receptacle shall be constructed to permit the mating plug to seat as intended without exposing the blades between the plane of the plug face and the plane of the receptacle rim.

10.2 The live parts of a receptacle shall not be exposed to contact when the receptacle is assembled and installed as intended. See 10.4.

10.3 With reference to the requirement specified in 10.2:

- a) An opening that will not permit the entrance of a 3/4 inch (19.1 mm) diameter rod is acceptable if a probe as illustrated in Figure 10.1 cannot be made to touch any uninsulated live part when inserted through the opening, and
- b) An opening that will permit the entrance of a 3/4 inch diameter rod is acceptable under the conditions specified in Figure 10.2.

Figure 10.1
Probe for uninsulated live parts

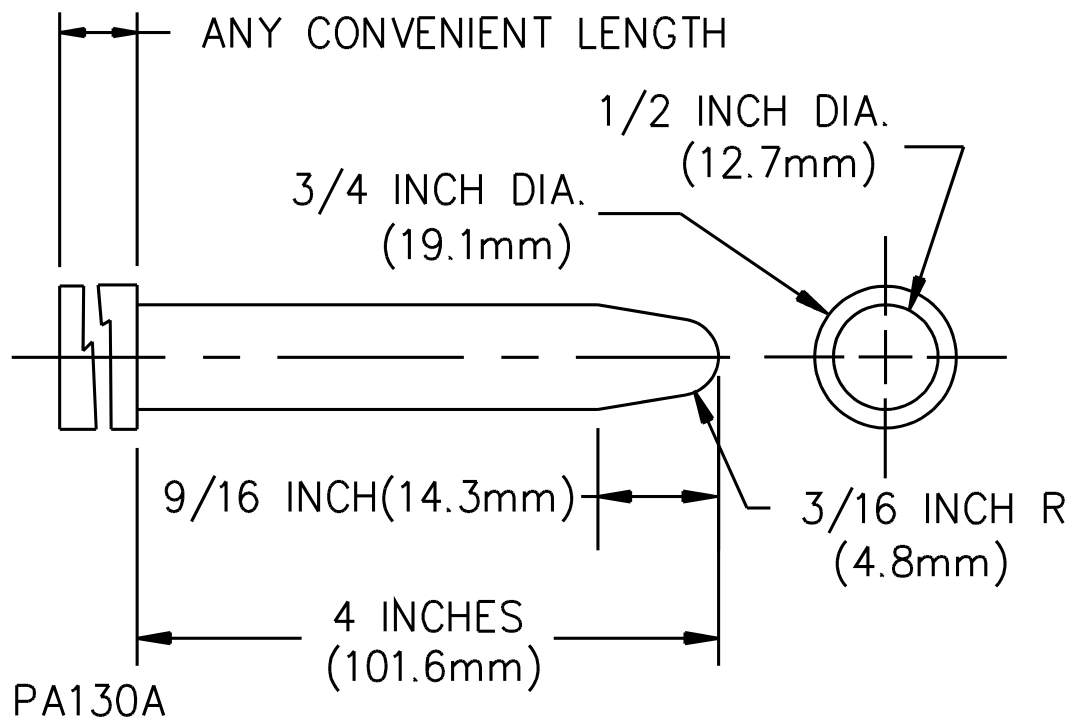
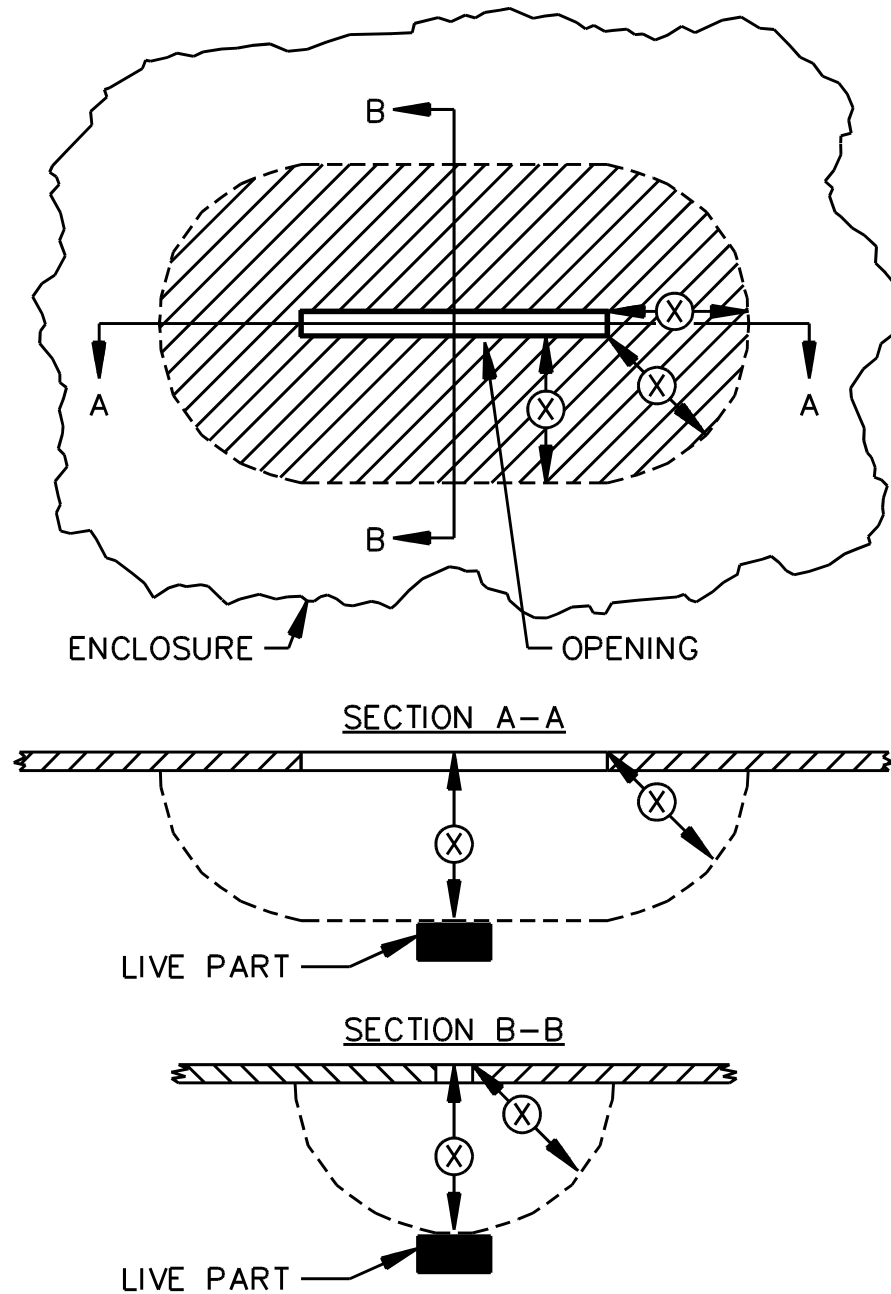


Figure 10.2
Opening in enclosure



EC100B

The opening is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire (1) less than X inches (mm) from the perimeter of the opening, as well as (2) within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod that can be inserted through the opening, but is not less than 4 inches (102 mm).

10.4 The requirements specified in 10.2 and 10.3 are not applicable to the following devices:

- a) A receptacle interlocked with a switch or a circuit breaker where the live parts of the receptacle are de-energized when the plug is withdrawn.
- b) A receptacle provided with a spring-loaded cover where the cover automatically returns to the closed position when the plug is withdrawn.
- c) A receptacle provided with a manually-replaceable cover if:
 - 1) The cover is secured to the receptacle enclosure by a chain or the equivalent, and
 - 2) The receptacle is provided with the marking specified in 48.10.

11 Spacings

11.1 Other than as noted in 11.2, the spacings in a plug and receptacle shall not be less than the values specified in Table 11.1.

11.2 The spacings specified in Table 11.1 do not apply to the inherent spacings of a component of the device. Such spacings are judged under the requirements for the component.

Table 11.1
Minimum spacings in inches (mm)

Parts involved		Potential involved in volts			
		General power devices			
		0 – 250		251 – 600	
Between any uninsulated live part and an uninsulated live part of opposite polarity, an uninsulated grounded dead metal part other than the enclosure, or an exposed dead metal part which is isolated (insulated)	Through air	3/16	(4.8)	3/16	(4.8)
	Over Surface	3/16	(4.8)	3/16	(4.8)
Between any uninsulated live part and the walls of a metal enclosure	Shortest distance	1/4	(6.4)	1/4	(6.4)

11.3 In measuring a spacing, an isolated dead metal part interposed between live parts of opposite polarity or between a live part and a grounded or an exposed dead metal part reduces the spacing by an amount equal to the dimension of the isolated dead metal part in the direction of the measurement.

11.4 An insulating barrier as specified in 11.5 – 11.9 may be provided as part or in place of the spacings specified in 11.1.

11.5 Other than as noted in 11.6, an insulating barrier or liner used as the sole separation between an uninsulated live part and a grounded dead metal part (including the enclosure) or between uninsulated live parts of opposite polarity, shall be of material that is acceptable for the mounting of an uninsulated live part and shall not be less than 0.028 inch (0.71 mm) thick. See also 11.6.

11.6 Fiber not less than 0.028 inch (0.71 mm) thick may be used as the sole separation between the enclosure and an uninsulated metal part electrically connected to a grounded-circuit conductor, if the operating temperature of the fiber is not more than 90°C (194°F).

11.7 Other than as noted in 11.8, an insulating barrier or liner that is used in addition to an air space in place of the required spacing through air shall not be less than 0.028 inch (0.71 mm) thick. If the barrier or the liner is of fiber, the air space shall not be less than 1/32 inch (0.8 mm), and if the barrier or the liner is of a material that is not acceptable for the support of an uninsulated live part, the air space provided shall be acceptable for the particular application. See 11.8.

11.8 A barrier or liner that is used in addition to no less than one-half the required spacing through air may be less than 0.028 inch (0.71 mm) thick but shall not be less than 0.015 inch (0.38 mm) thick if the barrier or liner is of a material that is:

- a) Acceptable for the mounting of an uninsulated live part,
- b) Of acceptable mechanical strength if exposed or otherwise likely to be subjected to mechanical damage,
- c) Held in place, and
- d) Located so that it will not be impaired by operation of the equipment in service.

11.9 Insulating material having a thickness less than that specified in 11.5, 11.7, and 11.8 may be used if found to be acceptable.

12 Assembly

12.1 A device shall be capable of being readily wired as intended.

12.2 A device involving two or more pieces shall be constructed so that any intended polarization will not be defeated by improper assembly during installation.

12.3 A screw upon which the general assembly of a device depends shall, where possible, be prevented from loosening or backing by sealing, staking, or an equivalent means.

12.4 A sealing compound shall be insulating, waterproof, and shall not soften at a temperature of 93°C (199°F). See 22.1 and 22.2.

12.5 Positive electrical contact shall be maintained at any point where a connection is made between current-carrying parts.

12.6 A receptacle shall not accommodate a plug other than one that is specifically designed for use with the combination.

12.7 Plugs and receptacles that have different electrical ratings shall not be interchangeable with one another.

13 Materials Applied to Joint Surfaces

13.1 Paint or a sealing material shall not be applied to the contacting surfaces of a joint.

13.2 A corrosion inhibiting grease such as petrolatum or soap-thickened mineral oils may be applied to the metal joint surfaces before assembly. The grease shall be of a type that does not harden because of aging, does not contain an evaporating solvent, and does not cause corrosion of the metal surfaces.

14 Protection Against Corrosion

14.1 A ferrous metal part other than stainless steel, shall be protected against corrosion, except at a joint surface, a shaft opening, and conduit threads, by zinc or cadmium coating, plating, enameling, painting, varnishing, or lacquering. A joint surface and conduit threads may be electroplated with zinc or cadmium.

14.2 Brass, copper, or lead-alloy (terne) are not acceptable for plating a ferrous metal part for protection against corrosion.

14.3 For a raintight product having a sheet steel enclosure, the corrosion protection shall comply with the requirements in 14.4 or in 14.5 and 14.6.

14.4 An enclosure of sheet steel having an average thickness less than 0.120 inch (3.05 mm) shall:

- a) Be galvanized by the hot-dip process after forming and assembly,
- b) Be made from hot-dipped sheets,
- c) Be provided with a metal coating at least the equivalent of zinc applied by the hot-dip process, or
- d) Be protected from corrosion by some other finish that has been found acceptable for the purpose.

14.5 An enclosure made of sheet steel having an average thickness of 0.120 inch (3.05 mm) or more may be formed from either hot-dipped or electroplated sheets, or may be protected from corrosion by some other acceptable finish. A cadmium coating shall not be less than 0.001 inch (0.025 mm) thick. A zinc coating shall be such that a sample of the coated steel will not show a fixed deposit of copper after four 1-minute immersions in the copper sulfate solution used in the Test Method for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip), ASTM 239-89. See 14.6.

14.6 If zinc-coated sheet steel has, in addition, a coat of alkyd-resin or other paint, the zinc coating need not comply with the requirement for zinc coating specified in 14.5, provided that an unpainted sample of the coated steel does not show a fixed deposit of copper after three 1-minute immersions in the copper sulfate solution. If two or more coats of such paint are employed, the unpainted sample need withstand only two 1-minute immersions without showing a fixed deposit of copper.