

Australian/New Zealand Standard™

Electrical equipment for mines and quarries—Explosion-protected three- phase restrained plugs and receptacles for working voltages up to and including 3.3 kV



AS/NZS 1299:2009

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-023, Electrical Equipment in Mines and Quarries. It was approved on behalf of the Council of Standards Australia on 26 November 2009 and on behalf of the Council of Standards New Zealand on 13 November 2009. This Standard was published on 9 December 2009.

The following are represented on Committee EL-023:

Australian Chamber of Commerce and Industry
Australian Coal Association
Australian Industry Group
Aviation and Marine Engineers Association, New Zealand
Department of Mines and Energy, Qld
Department of Mines and Petroleum, WA
Department of Primary Industries, Mine Safety NSW
Electrical Apparatus Service Association
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This Standard was issued in draft form for comment as DR 09020.

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Electrical equipment for mines and quarries—Explosion-protected three-phase restrained plugs and receptacles for working voltages up to and including 3.3 kV

Originated as AS 1299—1989.
Previous edition 1993.
Jointly revised and designated as AS/NZS 1299:2009.
Reissued incorporating Amendment No. 1 (March 2012).

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Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140.

ISBN 0 7337 9329 0

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-023, Electrical Equipment in Mines and Quarries, to supersede AS 1299—1993, *Electrical equipment for coal mines—Flameproof restrained plugs and receptacles*.

This Standard incorporates Amendment No. 1 (March 2012). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide requirements and guidance for explosion-protected three-phase restrained plugs and receptacles to manufacturers, users, regulatory authorities and associated interests and for use with other related Australian/New Zealand Standards and relevant mining regulations. It also is to allow for the use of existing compatible cable coupling systems and for the introduction of new non-compatible cable coupling systems.

This Standard differs from the previous edition in the following significant ways:

- (a) Recognizes the AS/NZS 60079 series of Standards.
- (b) Introduces provisions for alternative designs. Plugs and receptacles that are dimensionally compatible with this Standard are called Type A. Alternative designs are called Type B.
- (c) Updated figures showing critical compatibility dimensions and flamepaths ensure compatibility between different makes of Type A components.
- (d) Provides for transition devices between Type A and Type B components.
- (e) Increased emphasis on integrity of earth paths.
- (f) Clarifies test criteria.
- (g) Allows for higher current ratings.
- (h) Defines maximum voltage for restrained systems at 3.3 kV.
- (i) Removes reference to coal mines and includes mines and quarries.
- (j) Withdrawal of AS 1147.1, *Electrical equipment for coal mines—Insulating materials, Part 1: Materials for insulating power conducting components* and incorporation of test requirements into Appendix B of this Standard. Materials tested by authorities to Standards listed in Appendix B may be accepted without verification.
- (k) Outlines additional marking requirements in Clause 1.6.
- (l) Illustrates the quick-release concept in Figure 1.1.
- (m) Introduces the term ‘explosion-protected’ throughout the Standard.
- (n) Allows for non-metallic materials to be used in the construction of the components (refer to Clause 2.3).
- (o) Details requirements of earthing through the plugs and receptacles.
- (p) Allows for pins and socket earths in Type B designs (as opposed to scraping earth in Type A).
- (q) Defines the plug removal sequence (refer to Clause 2.11.2).
- (r) Increases earth size in cable reel receptacles from 6 mm² to 16 mm².
- (s) Increases phase barrier earth connection to at least 6 mm².

- (t) Provides template drawings to allow manufacturers of explosion-protected enclosures to design outlets that do not compromise the integrity of receptacles.
- (u) Establishes a test to ensure integrity of scraping earth contacts.
- (v) Adds Section 4 with figures and dimensions.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this standard.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electrical equipment for mines and quarries—Explosion-protected three-phase restrained plugs and receptacles for working voltages up to and including 3.3 kV**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the design and test requirements for explosion-protected three-phase restrained plugs and receptacles incorporating three power contacts, one pilot contact and possibly one or more auxiliary contacts, an earth contact and an earthed phase barrier intended for use with restricted earth-fault systems in mines and quarries with a working voltage up to and including 3.3 kV. Provision is also made for restrained back-to-back receptacles, which enable lengths of cable to be coupled together.

Restrained plugs and receptacles constructed to this Standard are not intended to be coupled or uncoupled while the circuit is energized.

The Standard covers two types of restrained plugs and receptacles:

(a) Type A

Designed according to Figures in this Standard that prescribe the dimensions necessary to interconnect plugs or receptacles from different manufacturers.

(b) Type B

Designed to dimensions that are not compatible with Type A plugs or receptacles. Type B plugs or receptacles cannot be plugged into or accept a Type A plug or receptacle under normal operation.

Type B plugs and receptacles do not comply with Figures 4.1 to 4.16 but comply with all other requirements of this Standard. Where there is a variation to a particular clause for Type B plugs and receptacles it is specifically stated. The use of transition devices between Type A and Type B systems is permitted.

This Standard also deals with some electrical and mechanical requirements, including the provision of earthed phase barriers to protect against interphase faults. It does not specify fully detailed designs.

This Standard provides for plug and receptacle discrimination, i.e. an arrangement whereby plugs and receptacles of different rated voltages or currents are physically prevented from being engaged.

The requirements of AS/NZS 1747 should be considered in the design of these devices.

NOTES:

- 1 The term 'receptacle' as used in this Standard is synonymous with the term 'socket-outlet' in AS/NZS 3000. The term 'receptacle' has been chosen to avoid confusion with the individual sockets within the plug.
- 2 Appendix A lists the information that a user should provide with any enquiry or order.
- 3 Appendix C lists the information which should be supplied by the designer or manufacturer.
- 4 A typical plug and receptacle (quick-release) assembly is shown in Figure 1.1 and a typical restrained back-to-back receptacle is shown in Figure 1.2.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- 1856 Electroplated coatings—Silver
- 2700 Colour standards for general purposes
- 60529 Degrees of protection provided by enclosures (IP Code)

AS/NZS

- 1747 Reeling, trailing and feeder cables used for mining—Repair, testing and fitting of accessories
- 1802 Electrical cables—Reeling and trailing—For underground coal mining purposes
- 1972 Electric cables—Underground coal mines—Other than reeling and trailing
- 2802 Electrical cables—Reeling and trailing for mining and general use (other than underground coal mining)
- 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- 3008 Electrical installations—Selection of cables
- 3008.1 Part 1: Cables for alternating voltages up to and including 0.6/1 kV (Series)
- 5000 Electric cables—Polymeric insulated
- 5000.1 Part 1: For working voltages up to and including 0.6/1 (1.2) kV
- 60079 Explosive atmospheres
- 60079.0 Part 0: Equipment—General requirements
- 60079.1 Part 1: Equipment—Protection by flameproof enclosures ‘d’
- 60079.7 Part 7: Equipment—Protection by increased safety ‘e’
- 60079.18 Part 18: Equipment—Construction, test and marking of type of protection encapsulation ‘m’ electrical apparatus

IEC

- 60093 Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials
- 60112 Method for the determination of the proof and the comparative tracking indices of solid insulating materials
- 60167 Methods of test for the determination of the insulation resistance of solid insulating materials
- 60216 Electrical insulating materials—Properties of thermal endurance
- 60216-1 Part 1: Ageing procedures and evaluation of test results
- 60243 Electric strength of insulating materials—Test methods (series)
- 61180 High-voltage test techniques for low-voltage equipment
- 61180-2 Part 2: Test equipment

ISO

- 62 Plastics—Determination of water absorption

ASTM

- D-570 Standard Test Method for Water Absorption of Plastics

DIN IEC

- 93/167 This refers to the DIN equivalents of IEC 60093 and IEC 60167

1.3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.3.1 Auxiliary contact pin

A rigid conducting member for other than electrical power circuits and pilot circuits intended to be inserted into an auxiliary contact socket of suitable form so as to make electrical contact.

1.3.2 Auxiliary contact socket

A resilient conducting member for other than electrical power circuits and pilot circuits intended to receive a suitable auxiliary contact pin so as to make electrical contact.

1.3.3 Cable reel receptacle, left-hand

A receptacle that is fitted to a standard drive shuttle car (see Figures 4.2 and 4.7).

1.3.4 Cable reel receptacle, right-hand

A receptacle that is fitted to an opposite standard drive shuttle car (see Figures 4.2 and 4.7).

1.3.5 Main contact pin

A rigid conducting member for electrical power circuits intended to be inserted into a main contact socket of suitable form so as to make electrical contact.

1.3.6 Main contact socket

A resilient conducting member for electrical power circuits intended to receive a suitable main contact pin so as to make electrical contact.

1.3.7 Phase barrier

An electrically conductive barrier that is earthed and is positioned to prevent an interphase fault between adjoining pins or adjoining sockets.

1.3.8 Pilot contact pin

A rigid conducting member for other than electrical power circuits intended to be inserted into a pilot contact socket of suitable form so as to make electrical contact.

1.3.9 Pilot contact socket

A resilient conducting member for other than electrical power circuits intended to receive a suitable pilot contact pin so as to make electrical contact.

1.3.10 Plug

A restrained device having contacts designed to engage with a receptacle and which is attached to a cable.

1.3.11 Receptacle

A restrained device having contacts that connect a plug to equipment and maintains the explosion-protected properties of the enclosure. Back-to-back receptacles are included.

1.3.12 Termination plug

A restrained device that engages with a receptacle to complete the explosion-protected enclosure of the receptacle. It enables full working voltages to be applied and cannot be attached to a trailing cable. The device may be used for controlling and monitoring (e.g. dummy plug and test plug).

1.3.13 Transition device

A device that allows Type A or Type B devices to be interconnected. The transition device need not have a consistent end to end current rating

1.4 SERVICE CONDITIONS

Restrained plugs and receptacles in accordance with this Standard shall be suitable to operate at ambient temperatures between -20°C and $+40^{\circ}\text{C}$. The average temperature over 24 h is not to exceed 35°C .

NOTE: The design of such devices should take into consideration conditions peculiar to mining, such as chemical fumes, wetting agents, stone dusting and other corrosive agents in mine water.

1.5 RATINGS, DIMENSIONS AND COLOUR CODING

1.5.1 Type A

The ratings, dimensions and colour coding of Type A restrained plugs and receptacles shall comply with Table 1.

1.5.2 Type B

Type B plugs and receptacles shall be colour coded in accordance with Table 1 to indicate their voltage rating.

Type B plugs and receptacles need not comply with the current ratings listed in Table 1.

A Type B plug or receptacle shall be of such dimensions that it cannot be connected to a Type A plug or receptacle without a transition device.

TABLE 1
RATINGS, DIMENSIONS AND COLOUR CODING

1	2	3	4
Voltage	Maximum current A	Colour code to AS 2700	For dimensions refer to figures in Section 4
660 V	60	X15 (Orange)	4.1
	125	X15 (Orange)	4.2
	150	X15 (Orange)	4.3
	300	X15 (Orange)	4.4
	425	X15/N24 (Orange/Silver Grey)	4.5
1.1 kV	60	B24 (Harbour Blue)	4.6
	125	B24 (Harbour Blue)	4.7
	150	B24 (Harbour Blue)	4.8
	300	B24 (Harbour Blue)	4.9
	300*	B24 (Harbour Blue)	4.10
	425	B24/N24 (Harbour Blue/Silver Grey)	4.11
	425*	B24/N24 (Harbour Blue/Silver Grey)	4.12
3.3 kV	300	R13 (Signal Red)	4.13
	300*	R13 (Signal Red)	4.14
	425	R13/N24 (Signal Red/Silver Grey)	4.15
	425*	R13/N24 (Signal Red/Silver Grey)	4.16

* Refers to six-pin plug and receptacles.

NOTE: 425 A plugs shall be colour coded to show a distinct band of Silver Grey at least 25 mm wide.

1.6 MARKING

Restrained plugs and receptacles shall be legibly and durably marked with the following information:

- (a) Manufacturer's name or trademark.
- (b) Manufacturer's component identification.
- (c) Voltage and current rating.
- (d) The symbol 'Ex'.
- (e) Type of protection used, e.g. 'd'. Where more than one type of protection is used, the symbol for the main type of protection shall appear first.
- (f) The symbol of the apparatus group, in accordance with AS/NZS 60079.0.
- (g) Certification number.
- (h) Serial number.
- (i) Construction type identification, i.e. Type A or Type B.
- (j) The warning 'Do not separate when energized'.

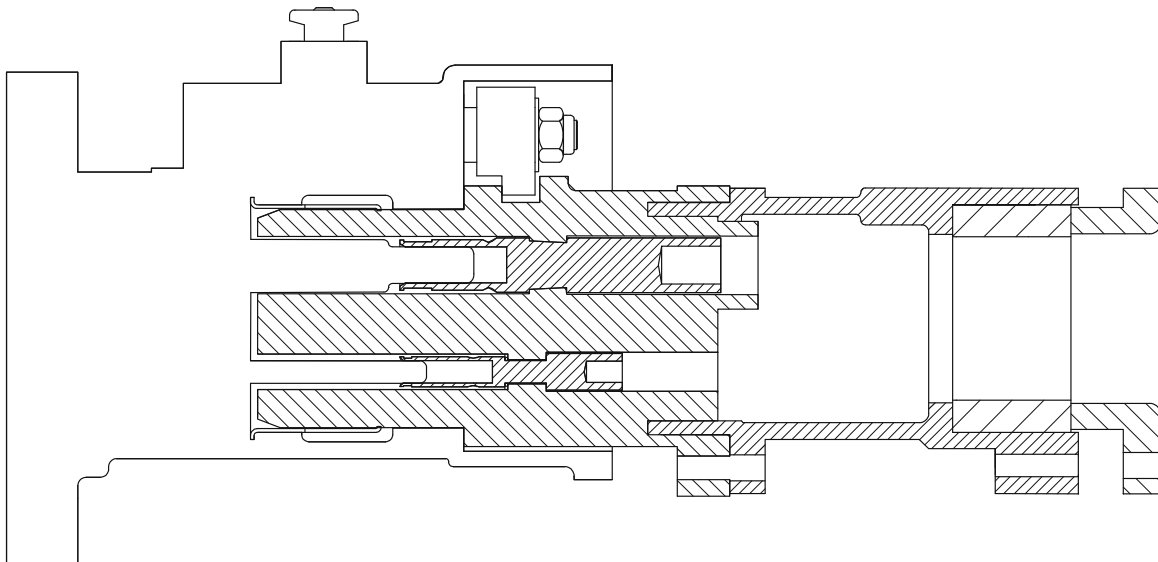


FIGURE 1.1 TYPICAL ASSEMBLY OF RESTRAINED PLUG AND RECEPTACLE

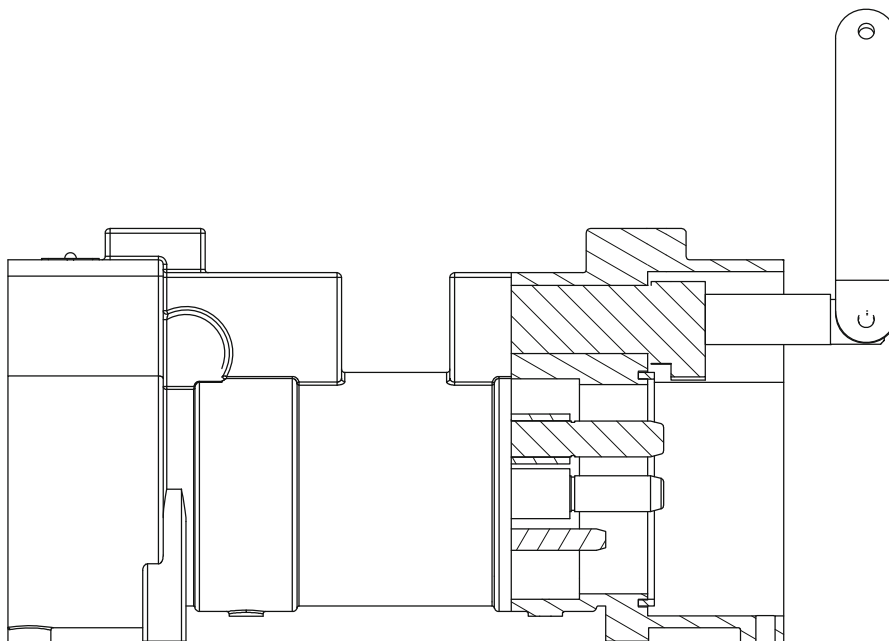


FIGURE 1.2 TYPICAL ASSEMBLY OF RESTRAINED BACK-TO-BACK RECEPTACLE

S E C T I O N 2 D E S I G N

2.1 ENCLOSURE

2.1.1 Explosion protection

The electrical contact chamber of restrained plugs, receptacles and back-to-back receptacles and transition devices shall, when coupled together, comply with the requirements of AS/NZS 60079.0 and AS/NZS 60079.1 for Group I apparatus.

Cable connection chambers shall comply with AS/NZS 60079.1, AS/NZS 60079.7 or AS/NZS 60079.18 for Group 1 equipment.

A receptacle fitted to an explosion-protected enclosure without a plug being inserted shall maintain the explosion-protected properties of the enclosure. This may be either by using a compound barrier or by explosion-protected design of the receptacle.

To reduce the possibility of sparking in the cable connection chamber it is recommended that explosion protection principles such as Ex 'e' and Ex 'm' be considered for this area.

NOTE: Refer to electrical connections in AS/NZS 60079.7.

2.1.2 Ingress protection

Receptacles and back-to-back receptacles shall achieve a minimum degree of protection against dust and water ingress of IP 55 in accordance with AS 60529, when coupled with a compatible plug.

The sealing method shall not interfere with the flamepath provided.

2.1.3 Receptacle mounting

Type A receptacle mountings shall comply with Figures 4.17 to 4.20 to maintain the explosion-protected properties of the receptacle and enclosure.

Where a Type B receptacle is designed to be mounted on a Type A template, Figures 4.17 to 4.20 shall be adhered to in order to maintain the explosion-protected properties of the receptacle and enclosure.

A minimum continuous flamepath of 12.5 mm shall be provided between the enclosure entry hole and the receptacle mounting hole.

2.2 CLEARANCE AND CREEPAGE DISTANCES

The clearance and creepage distance through casting compounds, distances between contact sockets, contact pins, phase barriers, cable conductors, end covers and metal housings of cable coupling devices, adaptors and adaptor compounding chambers, shall comply with the relevant requirements of AS/NZS 60079.7.

2.3 MATERIALS

The engaging portion of the case of the plug that protects the contact-sockets, shall be of metal having a tensile strength of not less than 450 MPa and an elongation at failure of not less than 10%.

For a Type B plug, the engaging portion of the case of the plug may be non-metallic provided that it has equivalent earth paths, mechanical strength and explosion protection to a Type A system.

If made of ferrous metal, the case shall be rustproof or, alternatively, its surface shall be treated so that it will resist corrosion without reducing the conductance of the earthing circuit.

The remaining portion of the case shall be either a suitable metal having a tensile strength of not less than 220 MPa and an elongation at failure of not less than 10% or a non-metallic material complying with the requirements of AS/NZS 60079.0 and AS/NZS 60079.1.

2.4 FASTENERS

All bolts, screws, set-screws, studs and nuts shall comply with AS/NZS 60079.0 and AS/NZS 60079.1, as appropriate.

2.5 CABLE GLANDS

Cable glands forming part of a restrained plug or receptacle shall be designed so that cables specified in AS/NZS 1802, AS/NZS 2802 and AS/NZS 1972 can be accommodated. They shall comply with the requirements of AS/NZS 60079.0.

2.6 TERMINALS

2.6.1 General

The terminals of restrained plugs and receptacles shall provide for crimped, soldered or clamped connections.

All connections shall be designed to resist loosening due to vibration or temperature variation.

NOTE: The use of slotted head grub screws is not recommended due to potential burring of the head and the limitation of the tightening torque.

2.6.2 Conductor insertion depth

Terminals shall provide for a conductor insertion depth of not less than that shown in Table 2.

TABLE 2
CONDUCTOR INSERTION DEPTH

Rating A	Insertion depth mm		
	Power core	Auxiliary core	Pilot core
60	15	10	10
125	20	10	10
150	20	10	10
300	25	10	10
425	25	10	10

NOTE: For Type B devices the minimum insertion depths will be taken from the closest current rating specified above.

2.7 CONTACT SOCKETS AND PINS

2.7.1 General

Contact sockets and pins shall meet the material and construction requirements of this Clause. The performance of the design is demonstrated by compliance with the tests of Clauses 3.2.3, 3.3.8, 3.3.9 and 3.3.10.

2.7.2 Materials

The electrical contact part of sockets and pins shall be of any suitable metal having—

- (a) a Brinell hardness of not less than 70 HB or a Vickers hardness of not less than 87 HV;
- (b) a volume resistivity of not more than 1.1 mΩ.m at 20°C;

Copper or brass contacts shall be silver-plated with a thickness of at least 8 μm in accordance with AS 1856 and comply with any of the test requirements of Section 3, or equivalent plating based on manufacturer's specification.

2.7.3 Construction of sockets

Sockets shall be constructed so that, when plugs and receptacles are coupled together, they shall—

- (a) make good electrical contact with the pins;
- (b) be self-adjusting to the extent necessary to accommodate the permitted tolerance on pitch; and
- (c) be provided with a facility to prevent overexpansion.

2.7.4 Location of sockets and pins

Contact sockets and pins for Type A devices shall be positioned as shown in Figures 4.1 to 4.16, as appropriate.

A termination plug may have contacts to suit its application.

2.7.5 Pins

The entry radius on a pin shall be not less than 3 mm or the entry taper shall be not less than 3 mm long and at an angle of not greater than 30°.

2.8 EARTHING

2.8.1 General

The through-earth capacity of a plug or receptacle shall be equivalent to the earth size of the maximum size cable nominated by the manufacturer as capable of being connected to the receptacle or plug and shall be tested in accordance with Clause 3.3.11.

All metallic external parts of plugs and receptacles shall make good electrical contact to prevent touch potential across those parts.

Where non-metallic external parts are used, effective earth screening shall be provided to prevent touch potential on any external surface due to component failure.

2.8.2 Phase barrier

The conductor forming the earth circuit from the phase barrier shall have a nominal cross-sectional area of at least 6 mm². The earth connection to the phase barrier shall be terminated to prevent self-loosening and to maintain contact pressure.

2.8.3 Scraping earth contact

The external surface of the engaging portion of the plug casing shall form part of a scraping earth contact and shall be electrically continuous with the remainder of the plug casing.

The receptacle shall have rubbing or scraping contacts attached mechanically to form part of a scraping earth contact.

The earth continuity circuit between plug and receptacle shall be made by contact between the external surface of the engaging portion of the plug casing and the internal surface of the scraping earth contact, which shall be electrically connected to the receptacle case. Figures 4.1 to 4.16 show the relevant dimensions according to the current rating.

The effectiveness of the through-earth contact shall be proved by satisfying the test of Clauses 3.2.4 and 3.3.11. The design shall be such that the earthing contact is made before the power contact pins and sockets come into contact, and is not broken until the contact pins and sockets have separated.

NOTE: A Type B device may not incorporate a scraping earth contact if an equivalent earthing capacity is provided.

2.8.4 Earth contact

A Type B device may have an alternative earth contact. The effectiveness of the through-earth contact shall be proved by satisfying the test of Clauses 3.2.5 and 3.3.11. The design shall be such that the earthing contact is made before the power contact pins and sockets come into contact, and is not broken until the contact pins and sockets have separated.

2.8.5 Terminals

One or more earthing terminals shall be provided to receive cable earthing conductors (including metallic screens). The terminal or terminals shall accept all of the earthing conductors for the maximum size cable nominated by the manufacturer. Terminals shall be designed to accommodate at least the earthing conductors of cables listed in AS/NZS 1802.

2.9 PHASE BARRIER

The phase barrier shall extend the full length of the solid interior.

The phase barrier shall be exposed at each end of the interior but not interfere with the connection of the mating device.

2.10 INSULATION

2.10.1 Material properties

The material used to insulate and support contact sockets, pins and metallic phase barriers shall comply with the relevant requirements of Appendix B. The intent of Appendix B is to specify a value for each property as determined by the test method of any of the listed Standards.

NOTE: It is not a requirement of this Standard that conformity of the manufacturer's specification of the material and their properties as required by Appendix B needs to be verified except where required by the AS/NZS 60079 series of Standards. A suitable manufacturer's data sheet may be accepted as satisfying the requirements of Appendix B.

2.10.2 Thermal endurance

The material used shall not degrade in an unsafe manner during the anticipated life cycle of the insulator.

The material shall be subjected to a thermal endurance test of AS/NZS 60079.0.

2.11 OPERATING AND RETAINING METHOD

2.11.1 General

A receptacle shall provide means for engaging, retaining and disengaging a plug, by locating a pawl in a corresponding slot in the plug and moving the plug axially relative to the receptacle. These operations shall be capable of being accomplished by means of this device, which shall operate positively on the plug.