

AS 1299:2022



STANDARDS
Australia



Electrical equipment for mines and quarries — Explosion-protected three-phase restrained and bolted cable coupling devices for working voltages up to and including 11 kV



AS 1299:2022

This Australian Standard® was prepared by EL-023, Electrical Equipment in Mines and Quarries. It was approved on behalf of the Council of Standards Australia on 05 August 2022.

This Standard was published on 19 August 2022.

The following are represented on Committee EL-023:

- Australian Cablemakers Association
- Australian Chamber of Commerce and Industry
- Australian Industry Group
- Aviation and Marine Engineers Association
- Better Regulation Division (Fair Trading, SafeWork NSW, TestSafe)
- Construction Forestry Miners and Energy Union
- Department of Mines, Industry Regulation and Safety WA
- Department of Regional NSW
- Engineers Australia
- Engineers Australia/Mining Electrical and Mining Mechanical Engineering Society
- Minerals Council of Australia
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This Standard was issued in draft form for comment as DR AS 1299:2022.

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ISBN 978 1 76113 904 8

Electrical equipment for mines and quarries — Explosion-protected three- phase restrained and bolted cable coupling devices for working voltages up to and including 11 kV

Originated as AS 1299—1973 and AS 1300—1973.
Previous editions AS/NZS 1299:2009 and AS/NZS 1300:2009.
Revised amalgamated and redesignated as AS 1299:2022.

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EL-023, Electrical Equipment in Mines and Quarries, to supersede AS/NZS 1299:2009, *Electrical equipment for mines and quarries — Explosion-protected three-phase restrained plugs and receptacles for working voltages up to and including 3.3 kV* and AS/NZS 1300:2009, *Electrical equipment for mines and quarries — Bolted explosion-protected three-phase cable coupling devices*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this document is to provide requirements and guidance for explosion-protected three-phase restrained plugs, receptacles and cable coupling devices 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 document differs from the previous edition in that it combines the previous AS/NZS 1299 and AS/NZS 1300 into one document (now designated AS 1299).

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

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Australian Standard®

Electrical equipment for mines and quarries — Explosion-protected three-phase restrained and bolted cable coupling devices for working voltages up to and including 11 kV

1 Scope and general

1.1 Scope

This document specifies the design and test requirements for explosion-protected three-phase restrained and bolted devices. These devices incorporate power contacts, one or more pilot contacts, an earth contact, an earthed phase barrier and possibly one or more auxiliary contacts. These devices are intended for use with restricted earth-fault systems in mines and quarries. Bolted devices are intended for use with a working voltage up to and including 11 kV. Restrained devices are limited to a working voltage of up to and including 3.3 kV.

This document is also applicable to back-to-back couplers (receptacles), that enable lengths of cable fitted with restrained plugs to be coupled together.

Restrained and bolted devices constructed to this document are not intended to be coupled or uncoupled while the circuit is energized.

This document covers two types of restrained and bolted devices as follows:

(a) **Type A**

Designed according to figures in this document that prescribe the dimensions necessary to interconnect restrained and bolted devices from different manufacturers.

(b) **Type B**

Designed to dimensions that are not compatible with Type A. Type B restrained and bolted devices cannot be plugged into or accept a Type A device under normal operation.

Type B restrained devices do not conform to [Figures 4.1 to 4.21](#) and Type B bolted devices do not conform to [Figures 5.1 to 5.8](#) but conform to all other requirements of this document. Where there is a variation to a particular clause for Type B restrained and bolted devices it is specifically stated. The use of transition devices between Type A and Type B systems is permitted.

This document 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 document 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.

NOTE 1 [Appendix A](#) lists the information that a user should provide with any enquiry or order.

NOTE 2 [Appendix C](#) lists the information which should be supplied by the designer or manufacturer.

NOTE 3 See [Figures 4.1 to 4.21](#) for dimensions of restrained devices.

NOTE 4 See [Figures 5.1 to 5.8](#) for dimensions of bolted devices.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1856, *Electroplated coatings — Silver*

AS 2700, *Colour standards for general purposes*

AS 60270, *High-voltage test techniques — Partial discharge measurements*

AS 60529, *Degrees of protection provided by enclosures (IP Code)*

AS/NZS 1802, *Electrical cables — Reeling and trailing — For underground coal mining purposes*

AS/NZS 1972, *Electric cables — Underground coal mines — Other than reeling and trailing*

AS/NZS 2802, *Electrical cables — Reeling and trailing for mining and general use (other than underground coal mining)*

AS/NZS 3008.1, *Electrical installations — Selection of cables, Part 1: Cables for alternating voltages up to and including 0.6/1 kV*

AS/NZS 5000.1, *Electric cables — Polymeric insulated, Part 1: For working voltages up to and including 0.6/1 (1.2) kV*

AS/NZS 60079.0, *Explosive atmospheres, Part 0: Equipment — General requirements*

AS/NZS 60079.1, *Explosive atmospheres, Part 1: Equipment — Protection by flameproof enclosures 'd'*

AS/NZS 60079.7, *Explosive atmospheres, Part 7: Equipment — Protection by increased safety 'e'*

AS/NZS 60079.18, *Explosive atmospheres, Part 18: Equipment — Construction, test and marking of type of protection encapsulation 'm' electrical apparatus*

IEC 60060-1, *High-voltage test techniques, Part 1: General definitions and test requirements*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60243 (series), *Electric strength of insulating materials — Test methods*

IEC 62631-3-1, *Dielectric and resistive properties of solid insulating materials, Part 3-1: Determination of resistive properties (DC Methods) — Volume resistance and volume resistivity — General method*

ISO 62, *Plastics — Determination of water absorption*

ASTM D570-98, *Standard Test Method for Water Absorption of Plastics*

1.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.3.1

auxiliary contact pin

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, for Type B this could be resilient

1.3.2**auxiliary contact socket**

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, for Type B this could be rigid

1.3.3**bolted adaptor**

device to connect a cable coupling device to equipment that maintains the explosion-protected properties of the enclosure. When joined to another coupler, the joint is held together using fasteners

Note 1 to entry: This could be used as a transition device.

1.3.4**bolted coupler**

device consisting of a housing, together with means for connecting cable conductors to insulated contact pins or sockets and forming an explosion-protected coupling. When joined to another coupler or adaptor, the joint is held together using fasteners

1.3.5**bolted end cover**

cover which, when bolted to the coupling face of a bolted coupler or adaptor, completes the explosion-protected enclosure of the bolted coupler device or adaptor and enables full working voltages to be applied

1.3.6**cable reel receptacle, left-hand**

receptacle that is fitted to a standard drive shuttle car (see [Figures 4.2](#) and [4.7](#))

1.3.7**cable reel receptacle, right-hand**

receptacle that is fitted to an opposite standard drive shuttle car (see [Figures 4.2](#) and [4.7](#))

1.3.8**main contact pin**

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, for Type B this could be resilient

1.3.9**main contact socket**

resilient conducting member for electrical power circuits intended to receive a suitable main contact pin so as to make electrical contact, for Type B this could be rigid

1.3.10**may**

indicates the existence of an option

1.3.11**phase barrier**

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

1.3.12**pilot contact pin**

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, for Type B this could be resilient

1.3.13**pilot contact socket**

resilient conducting member for other than electrical power circuits intended to receive a suitable pilot contact pin so as to make electrical contact, for Type B this could be rigid

1.3.14**restrained plug**

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

1.3.15**restrained receptacle**

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

1.3.16**shall**

indicates that a statement is mandatory

1.3.17**should**

indicates a recommendation

1.3.18**termination device**

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 cable

Note 1 to entry: The device may be used for controlling and monitoring (e.g. dummy plug and test plug).

1.3.19**transition device**

device that allows Type A or Type B devices of the same voltage to be interconnected

Note 1 to entry: The transition device need not have a consistent end to end current rating.

1.4 Service conditions

Restrained and bolted devices in accordance with this document shall be suitable to operate at ambient temperatures between $-20\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$. The average temperature over 24 h is not to exceed $35\text{ }^{\circ}\text{C}$. Where higher temperatures are possible, the devices shall be designed to reflect those conditions.

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 and bolted devices shall conform to [Tables 1\(A\)](#) and [1\(B\)](#).

1.5.2 Type B

Type B restrained and bolted devices shall be colour coded in accordance with [Table 1\(A\)](#)/(B) to indicate their voltage rating.

Type B restrained and bolted devices need not conform to the current ratings listed in [Table 1\(A\)](#)/(B).

Type B restrained and bolted devices shall be of such dimensions that they cannot be connected to Type A plugs, receptacles, couplers or adapters, or to incompatible Type B plugs, receptacles, couplers or adapters, without the use of transition devices.

Table 1(A) — Ratings, dimensions and colour coding for restrained devices

1	2	3	4
Voltage	Maximum current A	Colour code to AS 2700	For dimensions see 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 ^a	B24 (Harbour Blue)	4.10
	425	B24/N24 (Harbour Blue/Silver Grey)	4.11
	425 ^a	B24/N24 (Harbour Blue/Silver Grey)	4.12
3.3 kV	300	R13 (Signal Red)	4.13
	300 — 6 Pin	R13 (Signal Red)	4.14
	425	R13/N24 (Signal Red/Silver Grey)	4.15
	425 — 6 Pin	R13/N24 (Signal Red/Silver Grey)	4.16
Earth ing Receptacles	All current ratings	G13 Emerald Green, plus band to indicate voltage and current	N/A
425 A plugs shall be colour coded to show a distinct band at least 25 mm wide.			
^a Refers to six-pin plug and receptacles.			

Table 1(B) — Ratings, dimensions and colour coding for bolted devices

1	2	3	4
Voltage	Maximum current A	Colour code to AS 2700	For dimensions see Figures in Section 5
660 V	55	X15 (Orange)	5.1
	150	X15 (Orange)	5.2
	300	X15 (Orange)	5.2
	425	X15/N24 (Orange/Silver Grey)	5.2
1.1 kV	55	B24 (Harbour Blue)	5.1
	150	B24 (Harbour Blue)	5.2
	300	B24 (Harbour Blue)	5.2
	425	B24/N24 (Harbour Blue/Silver Grey)	5.2
3.3 kV and 6.6 kV	150	R13 (Signal Red)	5.3
	300	R13 (Signal Red)	5.3
	425	R13/N24 (Signal Red/Silver Grey)	5.3
11 kV	150	R13 (Signal Red)	5.4
	300	R13 (Signal Red)	5.4
	425	R13/N24 (Signal Red/Silver Grey)	5.4
	800	R13/N14 (Signal Red/White)	5.5
425 A and 800 A plugs shall be colour coded to show a distinct band at least 25 mm wide.			

1.6 Marking

Restrained and bolted devices 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) Ex marking in accordance with AS/NZS 60079.0.
- (e) Serial number.
- (f) Construction type identification, i.e. Type A or Type B.
- (g) Labelling: "Do not separate when energized".

2 Design

2.1 Enclosure

2.1.1 Explosion protection

The electrical contact chamber of restrained and bolted devices including transition devices shall, when coupled together, conform to the requirements of AS/NZS 60079.0 and AS/NZS 60079.1 for Group I apparatus.

Cable connection chambers shall conform to the applicable elements of AS/NZS 60079.0, AS/NZS 60079.1, AS/NZS 60079.7 or AS/NZS 60079.18 for Group I equipment.

2.1.1.1 Restrained receptacles

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 by explosion-protected design of the receptacle.

2.1.1.2 Bolted adapters

An adapter when mounted, that does not maintain the explosion protected properties of the enclosure, shall be fitted with a suitable cover to maintain the explosion-protected properties of the enclosure.

2.1.2 Ingress protection

All restrained and bolted devices 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 device.

The sealing method shall not interfere with the flamepath provided.

2.1.3 Mounting

Where a restrained and bolted device is designed to be mounted on a Type A template, [Figures 4.17 to 4.21](#) and [Figures 5.6 to 5.8](#) shall be adhered to in order to maintain the explosion-protected properties of the device and enclosure.

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

A Type B interface joint shall conform with AS/NZS 60079.1.

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 restrained and bolted devices, shall conform to the relevant requirements of AS/NZS 60079.7 and, where required, AS/NZS 60079.18.

2.3 Materials

The engaging portion of the case of the restrained and bolted device 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 %.

If made of ferrous metal, the case shall be rustproof or, alternatively, its surface 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 conforming to the requirements of AS/NZS 60079.0 and AS/NZS 60079.1.

The mating portion of a Type B restrained, and bolted device may be non-metallic provided that it has equivalent earth paths, mechanical strength and explosion protection to a Type A system.

2.4 Fasteners

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

2.5 Cable glands

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

NOTE The cable gland assembly is designed to effectively seal the cable to device interface for purposes of explosion protection.

2.6 Terminals

2.6.1 General

The terminals of restrained and bolted devices 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	Pilot core
55	15	10
60	15	10
125	20	10
150	20	10
300	25	10
425	25	10
800	25	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 conforming to the requirements of [Clauses 3.2.3, 3.3.9, 3.3.10](#) and [3.3.11](#).

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; and
- (b) a volume resistivity of not more than $1.1 \mu\Omega \cdot \text{m}$ 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 conform to any of the test requirements of [Section 3](#), or equivalent plating based on the manufacturer's specification.

2.7.3 Construction of sockets

Sockets shall be constructed so that, when restrained devices or bolted devices are coupled together, they shall—

- (a) make good electrical contact with the pins; and
- (b) be designed 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](#) and [Figures 5.1 to 5.5](#) as appropriate.

A termination device may have sockets or pins to suit its application.

For Type B devices the sockets and pins may be located in either of the (nominal) plug or the receptacle/adaptor.

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°.

2.7.6 Self-adjusting arrangements

For Type B devices, arrangements may be provided in the pins, sockets, insulation or insulation support materials that permits the self-adjusting of the alignment of the connection pins and sockets to ensure the pins and sockets maintain their designed current carrying capability.

2.8 Earthing

2.8.1 General

The through-earth capacity of a restrained and bolted devices shall be tested in accordance with [Clause 3.3.12](#).

All metallic external parts of restrained and bolted devices 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.

Provision shall be made on bolted devices for external earth-jumper straps to be attached to the body of the device and to cable glands, where the latter are used.

2.8.2 Phase barrier

For products that use a separate phase barrier the following shall apply:

- (a) 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 in a manner that prevents self loosening and maintains contact pressure.
- (b) The connection from the phase barrier shall be connected to the body of the device.
- (c) The phase barrier shall extend the full length of the solid interior.
- (d) The phase barrier shall be exposed at each end of the interior but not interfere with the connection of the mating device.

Restrained or bolted devices that utilize a full metallic interior shall have an equivalent earth size and be electrically continuous with the remainder of the device.

2.8.3 Scraping earth contact on restrained devices

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.

2.8.4 Type B alternate earth contact

A Type B device does not need to incorporate a scraping earth contact if an equivalent earthing facility is provided. Where an alternative is provided, 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 Insulation material properties

The material used to insulate and support contact sockets, pins and metallic phase barriers shall conform to 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.

EXAMPLE A manufacturer's data sheet may be accepted as satisfying the requirements of [Appendix B](#), excepting where verification is required by the AS/NZS 60079 series of Standards.

2.10 Operating and retaining method for restrained devices

2.10.1 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.

The receptacle shall be provided with a means of fitting a locking device to prevent the plug being removed or inserted when in service or during maintenance.

2.10.2 Removal operation

The primary removal operation involves the release of a retaining mechanism to allow a plug to be withdrawn to the extent of its travel. The secondary operation is the rotation of the pawl system, which allows the plug to be removed from the receptacle.

The primary operation shall take at least 200 ms between breaking the pilot and main contacts and shall ensure that the flamepath is maintained and remains engaged at the full extent of the linear outbound travel of the pawl.

All quick release receptacle systems shall automatically lock the withdrawal system when the plug is fully home. The locking method shall ensure that, when correctly operated, the plug cannot be withdrawn without releasing the automatic locking system.

The plug withdrawal sequence shall be —

- (a) break pilot connection; then
- (b) break main contacts; then

- (c) break scraping earth connection; then
- (d) break flamepath.

2.10.3 Type B devices

A Type B device does not have to use a pawl and slot in the plug as a retaining mechanism in order to conform with the plug withdrawal sequence of [Clause 2.10.2](#).

2.11 Cable reel receptacle

Each cable reel receptacle shall be provided with insulated flexible power conductors at least 600 mm long with a nominal cross-sectional area of not less than 35 mm². The pilot circuit conductor shall be at least 600 mm long with a nominal cross-sectional area of not less than 10 mm². The earth conductor shall have a nominal cross-sectional area of not less than 16 mm². Insulation of the power conductors, pilot conductor, earth conductor and auxiliary conductors (if provided) shall conform to AS/NZS 1802 or AS/NZS 5000.1.

2.12 Receptacle body

A pin and keyway shall be incorporated into —

- (a) 1 100 V 6 pin; and
- (b) 3 300 V 4 and 6 pin

receptacles and plugs to prevent the insertion of an incorrectly rated plug.

Provision shall be made for external earthing.

2.13 Earth receptacles and adapters

Earthing receptacles and adapters are specific devices for the connection and earthing of out of service cables.

They shall include the following features:

- (a) Maintain their explosion protection properties.
- (b) Internal connection facilities to connect all connections to a common earth point.
- (c) Provision for an external, suitably rated earth cable for connection to earth.
- (d) Coloured green.
- (e) Have a stripe to indicate the voltage and current rating as per the requirements of [Table 1A](#).

3 Testing

3.1 Categories of tests

The following two categories of tests are recognized:

- (a) Routine tests that are carried out on every component, restrained and bolted device nominated in the certification documentation. Such tests shall be in accordance with [Clause 3.2](#).
- (b) Type tests that are carried out on a single example, or small number of examples, of the components and assembled plugs and receptacles, the purpose of which is to establish that the design conforms to this document. Such tests shall be in accordance with [Clause 3.3](#).

NOTE Routine tests may be subcontracted to a test laboratory accredited for that purpose. In practice, it is typical for the manufacturer to carry out the routine testing. Type tests are undertaken by a test laboratory accredited for that purpose.

3.2 Routine tests

3.2.1 General

Routine tests are carried out to ensure that electrical equipment conforms with the tests listed in this document and the certification documentation.

3.2.2 High voltage test

A voltage test shall be applied to the interior insulant in a manner that simulates the clearance and creepage distances appropriate to the design of the component. Typical test equipment is described in IEC 60060-1.

A voltage test of twice the rated voltage plus 2 000 V a.c. shall be applied for a minimum period of 60 s, between all (collective or individual) power contact sockets or pins and the housing, phase barrier, pilot and, where provided, auxiliary or earth contact pins or sockets.

A voltage test of 1 000 V shall be applied between the pilot and, where provided, auxiliary contact pins or sockets and the metallic housing.

The test voltage shall be alternating, of a frequency between 40 Hz and 60 Hz and of substantially sinusoidal waveform. This requirement is fulfilled if the ratio between the peak value and the r.m.s. value is $\sqrt{2} \pm 3\%$. The Hipot tester shall be suitably rated for this task. Tripping currents should be kept as low as practicable. The voltage shall be gradually increased to the test voltage and shall be maintained for 60 s, after which it shall be gradually reduced before being switched off. During the test to earth, one pole of the testing transformer shall be connected to earth and to the housing.

The device shall pass this test if there are no disruptive discharges, i.e. flashovers or insulation punctures, during this test.

An insulation resistance test shall be performed prior to and after the high voltage test. The test shall be carried out with a direct current not exceeding the rated voltage of the component and shall not be less than 500 V d.c. The test voltage shall be applied for a sufficient time to enable the reading on the test instrument to become steady. The result of the second insulation resistance test is not to decrease by more than 10 % from the first insulation resistance test result and the final measured insulation resistance shall be not less than —

- (a) for working voltages up to and including 1 100 V, 100 M Ω ;
- (b) for working voltages above 1 100 V and up to and including 3 300 V, 1 000 M Ω ;
- (c) for working voltages above 3 300 V and up to and including 6 600 V, 5 000 M Ω ; and
- (d) for working voltages above 6 600 V and up to and including 11 000 V, 10 000 M Ω .

3.2.3 Contact pressure test

The insertion and withdrawal forces associated with the contact socket and its springing, shall conform to [Table 3](#).

NOTE An example of a test procedure is as follows.

- (a) The sockets be prepared by inserting and withdrawing a hardened, ground and polished pin with a diameter equal to the maximum allowable diameter of the pin.