

Australian/New Zealand Standard™

**Electric cables—Reeling and trailing—
For underground coal mining**



AS/NZS 1802:2018

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-023, Electric Equipment for Mines and Quarries. It was approved on behalf of the Council of Standards Australia on 5 March 2018 and by the New Zealand Standards Approval Board on 3 April 2018.
This Standard was published on 9 May 2018.

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
Construction Forestry Miners and Energy Union
Department of Mines, Industry Regulation and Safety (WA)
Department of Natural Resources, Mines and Energy (QLD)
Engineers Australia
National Association of Testing Authorities Australia
NSW Department of Industry , Skills and Regional Development
SafeWork NSW
University of Newcastle
Worksafe New Zealand

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com or Standards New Zealand web site at www.standards.govt.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of Standards Australia or the New Zealand Standards Executive at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS 1802:2017.

Australian/New Zealand Standard™

Electric cables—Reeling and trailing— For underground coal mining

Originated in Australia as AS C81—1941.
Originated in New Zealand as NZS/AS 1802:1992.
Jointly revised and redesignated as AS/NZS 1802:1995.
Previous edition 2003.
Sixth edition 2018.

COPYRIGHT

© Standards Australia Limited

© The Crown in right of New Zealand, administered by the New Zealand Standards Executive

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, PO Box 1473, Wellington 6140.

ISBN 978 1 76072 055 1

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-023, Electric Equipment for Mines and Quarries to supersede AS/NZS 1802:2003, *Electric cables—Reeling and trailing—For underground coal mining*.

This Standard aligns with AS/NZS 2802, *Electric cables—Reeling and trailing—For mining and general use (other than underground coal mining)* for cables that have been developed to meet the special requirements of the Australian surface mining industry.

The objective of this Standard is to specify construction and tests of reeling and trailing cables specifically designed for use in underground coal mines.

Where the method of testing differs from, or has not yet been included in AS/NZS 1660, the test method has been included in Clause 25 and appendices to this Standard.

While the requirements of underground coal mining continue to determine the cables to be incorporated in this Standard, it is recognized that many of these cables will be equally applicable to other installations, for example, underground metalliferous mines, ship loaders, travelling cranes, reclaimers at loading stations and other materials handling plants. Other requirements may apply in these applications.

Appropriate requirements for new types and sizes will be included in this Standard as the need arises.

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

- (a) Introduction of an earth fault screen.
- (b) Introduction of tests under Clause 25 to test the newly introduced earth fault screen.
- (c) Definition of the maximum volume resistivity for the insulation earth screens.
- (d) Due to increasing cable sizes and thus experience with larger cables, the maximum sheath thickness for all cables is limited to no more than 9.0 mm.

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

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

CONTENTS

	<i>Page</i>
1 SCOPE.....	4
2 REFERENCED DOCUMENTS.....	4
3 DEFINITIONS.....	5
4 VOLTAGE DESIGNATION	7
5 DESIGNATION AND APPLICATION.....	7
6 MAXIMUM CONDUCTOR TEMPERATURES	8
7 POWER, EARTH AND PILOT CONDUCTORS (OTHER THAN CENTRAL PILOT/CONTROL CORES AND COMPOSITE EARTH SCREENS)	8
8 CENTRAL PILOT/CONTROL CORES (TYPES 209, 210, 241, 245, 275 AND 280B ONLY).....	9
9 CONDUCTOR SCREEN.....	10
10 INSULATION ON CONDUCTORS (OTHER THAN EARTH CONDUCTORS)	11
11 TAPE OVER INSULATION OTHER THAN SEMI-CONDUCTIVE TAPE (TYPES 209, 210, 240 AND 260 ONLY).....	11
12 SCREENS.....	12
13 IDENTIFICATION OF CORES	15
14 CRADLE SEPARATORS	16
15 SEMICONDUCTIVE ELASTOMER COVERING FOR INTERSTITIAL EARTH CONDUCTORS (TYPES 241, 245, 275 AND 280B ONLY)	16
16 LAYING UP OF CORES	17
17 SEMICONDUCTIVE ELASTOMER SCREEN FOR CORE ASSEMBLY (TYPES 241, 245, 275 AND 280B ONLY)	17
18 REINFORCEMENT FOR CORE ASSEMBLY (TYPES 241, 245, 275 AND 280B ONLY).....	17
19 INNER SHEATH (TYPE 260 ONLY).....	18
20 PLIABLE ARMOUR (TYPE 260 ONLY).....	18
21 OUTER SHEATH (ALL CABLES).....	18
22 OPTIONAL OUTER SHEATH REINFORCEMENT (TYPES 209, 240 AND 260 ONLY).....	19
23 CONSTRUCTION AND DIMENSIONS (ALL CABLES).....	19
24 JOINTS IN COMPLETED CABLE LENGTHS	20
25 TESTS	20
26 MARKING (ALL CABLES)	27
27 FIGURES OF CONSTRUCTION AND TABLES OF DIMENSIONS.....	29
 APPENDICES	
A PURCHASING GUIDELINES	48
B DETERMINATION OF SHEATH THICKNESS AND PLIABLE ARMOUR STRAND SIZE USING FICTITIOUS CALCULATION METHOD	49
C MEASUREMENT OF VOLUME RESISTIVITY	51

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electric cables—Reeling and trailing—For underground coal mining****1 SCOPE**

This Standard specifies elastomer-insulated, elastomer-sheathed reeling and trailing electric cables for use in underground coal mines. An essential feature of this Standard is the requirement that cables used for alternating current supply be electrically symmetrical.

This Standard is intended to apply only to cables of the types provided for in Table 1 of this Standard.

This Standard also provides the basis of requirements for other sizes of cable not specified in this Standard.

NOTE: Purchasing guidelines are provided in Appendix A.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1931 High voltage test techniques (all parts)

AS/NZS

1125 Conductors in insulated electric cables and flexible cords

1660 Test methods for electric cables, cords and conductors

1660.1 Method 1: Conductors and metallic components

1660.2.1 Method 2.1: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods for general application

1660.2.2 Method 2.2: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods specific to elastomeric, XLPE and XLPVC materials

1660.2.5 Method 2.5: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods specific to cables above 1 kV

1660.3 Method 3: Electrical tests

1660.5.6 Method 5.6: Test for vertical flame propagation for a single insulated wire or cable

2802 Electric cables—Reeling and trailing—For mining and general use (other than underground coal mining)

3808 Insulating and sheathing materials for electric cables

3863 Galvanized mild steel wire for armouring of cables

5000 Electric cables—Polymeric insulated

5000.1 Part 1: For working voltages up to and including 0.6/1 (1.2) kV

ISO

1139 Textiles—Designation of yarns

3 DEFINITIONS

For the purpose of this Standard, the definitions given in the referenced Standards and those below apply.

3.1 Approximate value

A value which is neither guaranteed nor checked.

3.2 Bunch

A number of wires all of which are twisted together in the same direction and with the same length of lay throughout.

3.3 Composite screen

A screen comprising stranded or bunched copper wires applied in one direction and interwoven in the opposite direction with polyethylene terephthalate yarn, or its equivalent.

3.4 Conductor screen

A layer of non-metallic semiconductive material applied directly over the power conductor for the purpose of equalising stress through the insulation layer.

3.5 Covering

Semiconductive elastomer extruded over the earth conductors.

3.6 Cradle separator

A shaped section of elastomer, designed to support the core assembly, fill the centre interstice and provide a specified separation between individual power cores.

3.7 Direction of lay

The slope direction of the conductor wire, bunch, core, screen or armour strands when the stranded conductor or cable is held vertically. It is right-hand when the slope is in the direction of the central part of the letter Z, and left-hand when the slope is in the direction of the central part of the letter S.

3.8 Earth conductor

A conductor laid up in the cable for the purpose of providing earth continuity.

3.9 Fictitious diameter

Diameter calculated according to a formula based only on the cross-sectional area of conductor, number of cores and specified component dimensions and which ignores conductor make-up and the possibility of components having dimensions other than as specified.

NOTE: The fictitious value is only used to determine the thickness of the mechanical protective layers of the cable, that is inner and outer sheath and pliable armour strand size.

3.10 Insulation earth screen

A layer applied directly over the power core insulation for the purpose of providing a fault current path to earth.

3.11 Insulation screen

An insulation stress relief screen and/or an insulation earth screen.

3.12 Insulation stress relief screen

A layer applied directly over the power core insulation for the purpose of providing electrical stress relief through the insulation.

3.13 Length of lay

The axial length of one complete turn of the helix formed by a cable component, for example—

- (a) a bunch of a multiple stranded conductor;
- (b) a core of a laid-up core assembly; or
- (c) the strands of pliable armour in a cable.

3.14 Maximum conductor temperature

The permitted maximum temperature at the surface of the conductor.

3.15 Multiple-stranded conductor

A group of bunches or strands laid up helically and symmetrically such that within any one layer the length of lay of bunches or strands is uniform.

3.16 Pilot/control core

An insulated conductor for use in conjunction with a protection or other control system.

3.17 Pitch circle diameter

The diameter of a circle which passes through the midpoints of like cable components, for example—

- (a) a given layer of bunches or strands in a multiple stranded conductor, or the laid-up cores of a multicore circular cable; or
- (b) the composite screen of a core or strands of pliable armour in a circular cable.

3.18 Power core

A power conductor with insulation of the appropriate voltage grade including, where applicable, semiconductive and composite screens.

3.19 Reeling and trailing cable

A cable having flexible conductors, insulation incorporating conductor and insulation screens where appropriate, filling, reinforcement where appropriate, one or more protective layers, and being specially designed to provide a flexible electrical connection between portable or mobile equipment and a point of supply.

3.20 Routine tests

Tests made by the manufacturer on all completed cable to demonstrate the integrity of the cable.

3.21 Sample tests

Tests made by the manufacturer on samples of completed cables or components taken from completed cables, at a specified frequency, so as to verify that the finished product meets the design specification.

3.22 Strand

An assembly of wires laid up helically in one or more layers.

3.23 Type tests

Tests required to be made before supplying on a general commercial basis a type of cable covered by this Standard, to demonstrate performance characteristics to satisfy the intended application. These tests are such that after they have been made, they need not be repeated unless changes are made in the cable materials or design which might change the performance characteristics.

4 VOLTAGE DESIGNATION

Due to common usage in the mining industry, cables in this Standard have voltages designated using ‘phase voltage’/‘phase voltage’. However, although the cables specified for use with a.c. in this Standard are suitable in non-effectively earthed systems they are not intended for continuous operation with one phase earthed.

The voltage designation takes into consideration the fact that the system voltage may vary up to 9.1 percent from the designated voltage.

5 DESIGNATION AND APPLICATION

Cables are designated by means of a type number. The type number incorporates reference to the voltage, e.g. Type 209.3 identifies Type 209 rated at 3.3/3.3 kV.

Types of cables and their applications are listed in Table 1.

NOTE: For the cables specified in this Standard for use in underground coal mines, the first digit of the type number is 2. For those specified in AS/NZS 2802, for use in other than underground mining, the first digit of the type number is 4. These initial numerals have been chosen so that, for cables of like construction (e.g. as in the case of Types 209 and 409), the possibility of mistaken identity is reduced even after the cable has been worn or damaged.

TABLE 1
TYPES OF CABLES

1	2	3	4
Type No.	Description and typical intended application	Voltage designation kV	Details of construction and dimensions
	Cables for general use (excluding shuttle cars):		
209	Composite screened three-core cable with central pilot core	1.1/1.1 to 11/11	Figure 3 and Table 9
240	Composite screened three-core cable with interstitial pilot cores	1.1/1.1 to 11/11	Figure 5 and Table 11
241	Semiconductive earth screened three-core cable with interstitial earth conductors and a central pilot core	1.1/1.1 to 11/11	Figure 6 and Table 12
245	Semiconductive earth screened three-core cable with interstitial earth conductors and three central pilot/control cores	1.1/1.1 to 3.3/3.3	Figure 7 and Table 13
260	Composite screened pliable armoured three-core cable with interstitial pilot cores	1.1/1.1 to 11/11	Figure 8 and Table 14
	Cables for general use (including shuttle cars):		
280B	Semiconductive screened three-core cables with interstitial earth conductors and a central pilot core	1.1/1.1	Figure 10 and Table 16
	Cable for hand-held boring machines:		
210	Composite screened three-core cable with central pilot core	1.1/1.1	Figure 4 and Table 10
	Cables for shuttle cars:		
275	Semiconductive screened three-core cable with interstitial earth conductors and a central pilot core	1.1/1.1	Figure 9 and Table 15

6 MAXIMUM CONDUCTOR TEMPERATURES

The maximum conductor temperature of cables is specified in Table 2.

The emergency operation temperature (indicated in Column 2 of Table 2) is applicable for an average, over several years, of not more than one period per year. No period shall exceed 36 h and there shall not be more than three periods in any 12 consecutive months. The service life of cables may be reduced if flexed or reeled during emergency operation.

TABLE 2
MAXIMUM CONDUCTOR TEMPERATURE

1	2	3
Normal operation	Emergency operation	Short-circuit operation (5 s maximum duration)
°C	°C	°C
90	130	250*

* Account should be taken of the possibility that tinning could melt at 250°C.

NOTE: With respect to the hazard of hot surface ignition of coal dust maximum surface temperature of the cable is not to exceed 150°C under any circumstances.

7 POWER, EARTH AND PILOT CONDUCTORS (OTHER THAN CENTRAL PILOT/CONTROL CORES AND COMPOSITE EARTH SCREENS)

7.1 General

Power, earth and pilot conductors shall consist of tinned annealed copper wires complying with the appropriate requirements of AS/NZS 1125, except that the wires taken from the completed cable need not comply with the continuity test for tin plating specified in AS/NZS 1660.1. Conductor sizes from 1.5 mm² up to and including 4 mm² shall be Class 5 flexible conductors and conductor sizes greater than 4 mm² and up to 400 mm² shall be multiple-stranded circular flexible conductors (rope lay).

Tables 11 to 16 specify the standard interstitial conductors appropriate for a given cable.

Power, earth and pilot conductors may consist of a larger number of smaller diameter wires provided that the individual wires are not less than 0.19 mm or 50 percent of the nominal diameter rounded to one decimal place for a given conductor size, whichever is the greater, and provided that the conductor is of at least equal cross-sectional area to the standard conductor.

7.2 Joints

Joints shall comply with the appropriate requirements of AS/NZS 1125.

7.3 Direction of lay

The direction of lay of wires and of bunches or strands shall be such as to minimize cable distortion in service.

7.4 Length of lay of bunches for interstitial conductors (Types 240, 241, 245, 260, 275 and 280B only)

The bunches (as distinct from wires in the bunches) forming interstitial conductors shall be laid up with a length of lay not exceeding nine times the pitch circle diameter of the interstitial conductor bunches.

7.5 Resistance of earth and interstitial pilot conductors

These shall be as follows:

(a) Types 241 and 245

Except where a specific resistance value applies, as specified below, the electrical d.c. resistance of the three interstitial earth conductors combined, when expressed as a ratio to the maximum permissible resistance of one associated power conductor (refer to AS/NZS 1125), shall not exceed the following values:

- (i) For all cables rated at 3.3/3.3 kV and above, and for cables rated at 1.1/1.1 kV with power conductors up to and including 70 mm² nominal cross-sectional area, the ratio 2.0.
- (ii) For cables rated at 1.1/1.1 kV with power conductors larger than 70 mm² nominal cross-sectional area, the ratio or value 3.0 or 0.547 Ω/km, whichever is the lesser.

(b) Types 240 and 260

Except where a specific resistance value applies, as is specified below, the electrical d.c. resistance of the three interstitial pilot conductors combined, when expressed as a ratio to the maximum permissible resistance of one associated power conductor (refer to AS/NZS 1125), shall not exceed the following values:

- (i) For cables with power conductors up to and including 70 mm² nominal cross-sectional area, the ratio 2.0.
- (ii) For cables with power conductors larger than 70 mm² nominal cross-sectional area, the ratio or value 3.0 or 0.547 Ω/km, whichever is the lesser.

(c) Types 275 and 280B

Except where a specific resistance value applies, as is specified below, the electrical d.c. resistance of the three interstitial earth conductors combined, when expressed as a ratio to the maximum permissible resistance of one associated power conductor (refer to AS/NZS 1125), shall not exceed the following values:

- (i) For cables with power conductors up to and including 50 mm² nominal cross-sectional area, the ratio 1.333.
- (ii) For cables with power conductors of 70 mm² nominal cross-sectional area, the ratio 2.0.
- (iii) For cables with power conductors larger than 70 mm² nominal cross-sectional area, the ratio or value 3.0 or 0.547 Ω/km, whichever is the lesser.

8 CENTRAL PILOT/CONTROL CORES (TYPES 209, 210, 241, 245, 275 AND 280B ONLY)

8.1 Conductor material and resistance

Central pilot or control conductors shall comply with Clause 7.1. The conductor resistance of each pilot or control core shall not exceed the following values:

- (a) For cables, other than Type 245, having power conductors of nominal cross-sectional area up to and including 35 mm² 5.5 Ω/100 m length of cable.
- (b) For cables having power conductors of nominal cross-sectional area above 35 mm² and all Type 245 cables 3 Ω/100 m length of cable.

8.2 Extensibility of pilot conductor

Central pilot conductors (Types 209, 210, 241, 275 and 280B only) shall meet the requirements of Test 5 in Table 7.

8.3 Central pilot/control cores (Type 245)

Central pilot/control cores shall be laid up with a right-hand direction of lay. The length of lay, expressed as a multiple of the pitch circle diameter of the pilot/control core assembly, shall not exceed 13 times.

8.4 Joints in central pilot/control conductor

Individual wires may be joined in accordance with AS/NZS 1125. The conductor is not to contain a complete joint.

8.5 Material and thickness of insulation

Central pilot/control conductors shall have an insulation of R-EP-90 complying with Clause 10. The thickness of insulation shall be not less than 0.50 mm at any point.

8.6 Location

The pilot/control cores shall be located in the centre of the cradle separator.

9 CONDUCTOR SCREEN

9.1 General

All cables having a voltage rating of 3.3/3.3 kV and above shall have a semiconductive screen applied directly over each power conductor. The screen shall be applied by taping or extrusion, or both.

9.2 Material

Any extruded semiconductive screen shall be made of cross-linked polymeric material.

Any taped screen shall be made of textile-reinforced semiconductive tape.

In both cases the material shall be compatible with and have a temperature rating not less than that of the insulation.

9.3 Application

9.3.1 *Extruded screen*

The extruded material shall bond to the insulation material so that it is not possible to separate the two materials without damage to their interface.

9.3.2 *Taped screen*

One or more tapes shall be applied free of creases. Where one tape is used, this shall be applied with an overlap of 50 percent of the tape width.

9.3.3 *Combined taped and extruded screen*

The tape shall be applied directly on the conductor, followed by the extruded screen.

The extruded screen need not be bonded to the taped screen.

9.4 Removal from conductor

The conductor screen shall not migrate into or adhere to the conductor.

9.5 Thickness

9.5.1 *Extruded screen or combined taped and extruded screen*

The screen thickness, determined by the method specified for measurement of insulation thickness in AS/NZS 1660.2.1, shall be not less than 0.30 mm at any point of the extruded or combined taped and extruded screen.

9.5.2 *Taped screen*

The minimum thickness of the tape for a taped screen when not in combination with the extruded screen shall be 0.1 mm.

9.6 Tests

The tests shall be performed as set down in Table 7.

10 INSULATION ON CONDUCTORS (OTHER THAN EARTH CONDUCTORS)

10.1 Material

The insulation shall be R-EP-90 in accordance with AS/NZS 3808.

10.2 Application

The insulation shall be applied by the extrusion process.

The application shall be as follows:

- (a) For all pilots and for 1.1/1.1 kV designated cables the insulation shall fit closely on, but not adhere to, the conductor.

At the discretion of the manufacturer, a separator tape may be applied immediately over the power and pilot conductor. Any separator tape shall be coloured or opaque if it does not adhere to the insulation.

- (b) For power cores designated 3.3/3.3 kV and above the insulation shall be bonded to the extruded conductor screen if applied, and does not need to be bonded to the taped screen.

10.3 Thickness

The thickness of insulation on conductors other than central pilot/control conductors, determined by the method specified in AS/NZS 1660.2.1 and Clause 25.2, shall be not less than the thickness specified (t_i) in Tables 9 to 16, as appropriate.

The minimum thickness of insulation at any point shall not fall below the specified thickness by more than 10 percent of the specified thickness plus 0.10 mm, that is,

$$\text{minimum thickness} = (0.9t_i - 0.10 \text{ mm}) \quad \dots 1$$

NOTE: See Clause 8.5 for requirements for insulation on central pilot/control conductors.

10.4 Tests

All tests shall be performed as set down in Table 7.

11 TAPE OVER INSULATION OTHER THAN SEMI-CONDUCTIVE TAPE (TYPES 209, 210, 240 AND 260 ONLY)

11.1 Material

The tape shall comprise a textile fabric approximately 0.1 mm thick.

11.2 Application

The tape shall be applied with an overlap of not less than 10 percent of the tape width or 2 mm, whichever is the greater.

For Types 209.1, 210.1, 240.1 and 260.1, a tape shall be applied directly over the insulation of each power core.

For Types 240 and 260 (all voltage ratings), a tape shall be applied over the insulation of all interstitial cores.

The tape shall be removable without damage to the insulation.

12 SCREENS

12.1 General

The screens over power core insulation shall comprise the following:

- (a) Types 209, 240 and 260 rated 3.3/3.3 kV and above
Semiconductive elastomer (see Clause 12.2) or textile reinforced semiconductive tape (see Clause 12.4) or a combination of the two, followed by a composite screen.
- (b) Types 241 and 245
Semiconductive elastomer earth screen only (see Clause 12.3).
- (c) Type 280B
Textile reinforced semiconductive tape only (see Clause 12.4).

12.2 Semiconductive elastomer insulation stress relief screen

12.2.1 Material

The material shall comprise a layer of cross-linked semiconductive elastomer which shall be compatible with the insulation. It shall comply with the requirements of Table 7.

12.2.2 Application

The semiconductive elastomer shall be applied directly over the insulation of each power core.

12.2.3 Thickness of semiconductive screen

The average thickness of the screen, determined by the method specified for measurement of insulation thickness in AS/NZS 1660.2.1, shall be not less than 0.8 mm.

The thickness at any point shall be not less than 0.65 mm or more than 1.20 mm.

12.2.4 Requirements for stripping of screen

The semiconductive screen shall be capable of being hand stripped without damage to the insulation and shall comply with the requirements of Table 7.

12.2.5 Tests

Tests on a semiconductive screen shall be performed as set down in Table 7.

12.3 Semiconductive elastomer insulation earth screen

12.3.1 Material

The material shall comprise a layer of cross-linked semiconductive elastomer which shall be compatible with the insulation. It shall comply with the requirements of Table 7.

12.3.2 Application

The semiconductive elastomer shall be applied directly over the insulation of each power core.

12.3.3 *Thickness of semiconductive screen*

The average thickness of the screen, determined by the method specified for measurement of insulation thickness in AS/NZS 1660.2.1, shall be not less than 0.8 mm.

The thickness at any point shall be not less than 0.65 mm or more than 1.20 mm.

12.3.4 *Requirements for stripping of screen*

The semiconductive screen shall be capable of being hand stripped without damage to the insulation and shall comply with the requirements of Table 7.

12.3.5 *Tests*

Tests on semiconductive insulation earth screens shall be performed as set down in Table 7.

12.4 Textile reinforced semiconductive tape screen (Types 209, 240 and 260 only)

12.4.1 *Material*

The semiconductive tape shall comprise a textile fabric, coated with a semiconductive elastomer and having a continuous print on one side identifying it as being semiconductive. It shall be compatible with the insulation of the power cores.

The volume resistivity of the tape shall comply with the requirements of Table 7.

When not in combination with a semiconductive elastomer screen, the average thickness of the tape shall be not less than 0.2 mm. When in combination with a semiconductive elastomer screen, the combined average thickness shall be not less than 0.6 mm.

12.4.2 *Application*

The semiconductive tape shall be applied with an overlap of not less than 10 percent of tape width or 2 mm, whichever is the greater.

It shall be capable of being removed by hand without damage to the insulation.

Where tape is applied in combination with a semiconductive elastomer screen, the tape shall be outermost, with the printed side of the tape facing outwards.

12.5 Textile reinforced semiconductive tape screen (Type 280B only)

12.5.1 *Material*

The semiconductive tape shall comprise a textile fabric, coated with a semiconductive elastomer. It shall be compatible with the insulation of the power cores.

The volume resistivity shall comply with the requirements of Table 7.

The thickness of the tape shall be not less than 0.1 mm.

12.5.2 *Application*

Two layers of the semiconductive tape shall be helically applied immediately over the insulation.

They shall be capable of being removed by hand without damage to the insulation.

12.6 Composite screen (Types 209, 210, 240 and 260 only)

12.6.1 *Construction*

Composite screens shall consist of copper strands interwoven with polyethylene terephthalate yarn or equivalent.

The copper strands shall be applied with a right-hand direction of lay and shall be interwoven in the left-hand direction with the yarn, thus forming a braid. Each of the textile fibrous members shall be not less than R60 tex (refer to ISO 1139).

Each strand shall consist of seven tinned annealed copper wires, each having a nominal diameter within the limits of 0.25 mm and 0.50 mm, inclusive. The recommended strand size for each cable is shown in Tables 9, 10, 11 or 14, as appropriate.

NOTE: A suitable semiconductive tape may be applied over the composite screen.

12.6.2 Joints

There shall be no joints in the complete braid. Where renewal of spindles is necessary, the ends of the individual copper strands of a spindle shall be butt-jointed with silver solder.

Such butt-jointed screen strands shall be free from sharp edges, solder lumps or similar imperfections.

The breaking strength of a butt-soldered joint shall be not less than 80 percent of a strand not containing a joint.

There shall be not more than one spindle renewal in any 1 m length of core.

12.6.3 Length of lay

The length of lay, expressed as a multiple of the pitch circle diameter of the screen, shall not exceed 4.5 times.

12.6.4 Coverage

The coverage by the copper shall be not less than 80 percent when derived from the following equation:

$$\text{Percentage coverage} = \frac{W}{m} \times 100 \quad \dots 2$$

where

W = number of strands $\times$ diameter of single strand, in millimetres

$$m = \frac{L\pi d}{\sqrt{(\pi d)^2 + L^2}}$$

L = axial length or pitch of one complete turn of a screen strand, in millimetres

d = pitch diameter of screen strands, in millimetres, taken as the nominal diameter under the composite screen plus the diameter of one strand together with an allowance for increased thickness due to opposite weave yarn.

12.6.5 Resistance

Except where a specific resistance value applies as is specified below, the electrical d.c. resistance of the three screens combined, when expressed as a ratio to the maximum permissible resistance of one associated power conductor (refer to AS/NZS 1125), shall not exceed the following values:

- (a) For Type 210, the ratio 1.0.
- (b) For cables rated at 3.3/3.3 kV and above and for cables rated at 1.1/1.1 kV with power conductors up to and including 70 mm² nominal cross-sectional area, the ratio..... 2.0.
- (c) For cables rated at 1.1/1.1 kV with power conductors larger than 70 mm² nominal cross-sectional area, the ratio or value..... 3.0 or 0.547 Ω /km whichever is the lesser.

13 IDENTIFICATION OF CORES

13.1 General

Insulated conductors shall be distinctly and durably identified in accordance with Clauses 13.2 and 13.3.

13.2 Identification method

The identification method used shall be as indicated in Tables 3 and 4. The letters in Table 3 indicate the following methods:

- (a) Colour-coded insulation.
- (b) Colour-coded or continuously numbered proofed tape over the insulation.
- (c) Colour-coded or continuously numbered semiconductive tape over the insulation.
- (d) Colour-coded yarn in composite screen.
- (e) Types 241 and 245 only. Colour-coded or numbered semiconductive elastomer insulation earth screen, identifiable at intervals not greater than 300 mm.

TABLE 3
CORE IDENTIFICATION METHOD

1	2	3	4	5
Type No.	Voltage designation, kV			
	≤1.1/1.1		≥3.3/3.3	
	Power cores	Pilot cores	Power cores	Pilot cores
209	(a), (b) or (d)	(a)	(a), (c) or (d)	(a)
210	(a), (b) or (d)	(a)	not applicable	not applicable
240	(a), (b) or (d)	(a) and (b)*	(a), (c) or (d)	(a) and (b)*
241	(a) or (e)	(a)	(a) or (e)	(a)
245	(a) or (e)	Refer Table 4	(a) or (e)	(a)
260	(a), (b) or (d)	(a) and (b)*	(a), (c) or (d)	(a) and (b)*
275	(a)	(a)	not applicable	not applicable
280B	(a)	(a)	not applicable	not applicable

* Grey or white tape may be used.

13.3 Identification and rotational sequence

13.3.1 Identification by colours

Where identification is achieved by the use of colours, the colours and rotational sequence shall be in accordance with Table 4. Where colouring of power cores is not practicable, see Clause 13.3.2.

13.3.2 Identification by numbers

Where identification of power cores is achieved by numbering, the core colours shall be replaced by numbers, in the sequence specified in Clause 13.3.1, as follows:

- (a) No. 1 shall take the place of the red core.
- (b) No. 2 shall take the place of the white core.
- (c) No. 3 shall take the place of the blue core.

The printed power cores shall be identifiable at intervals of not greater than 300 mm.