AS/NZS 1802:2018

Australian/New Zealand Standard™

Electric cables—Reeling and trailing—For underground coal mining





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Australian Chamber of Commerce and Industry
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Construction Forestry Miners and Energy Union
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Australian/New Zealand Standard™

Electric cables—Reeling and trailing—For underground coal mining

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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.

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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

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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.

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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.

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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

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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 mm^2 up to and including 4 mm^2 shall be Class 5 flexible conductors and conductor sizes greater than 4 mm^2 and up to 400 mm^2 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.

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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 mm^2 nominal cross-sectional area, the ratio ..... 2.0.

(ii) For cables rated at 1.1/1.1 kV with power conductors larger than 70 mm^2 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 mm^2 nominal cross-sectional area, the ratio ..... 2.0.

(ii) For cables with power conductors larger than 70 mm^2 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 mm^2 nominal cross-sectional area, the ratio ..... 1.333.

(ii) For cables with power conductors of 70 mm^2 nominal cross-sectional area, the ratio ..... 2.0.

(iii) For cables with power conductors larger than 70 mm^2 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 mm^2 ..... 5.5 Ω/100 m length of cable.

(b) For cables having power conductors of nominal cross-sectional area above 35 mm^2 and all Type 245 cables ..... 3 Ω/100 m length of cable.

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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.

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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,

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

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.

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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.

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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).

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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:

$$\text{Percentage coverage} = \frac{W}{m} \times 100 \qquad \ldots 2$$

where

W = number of strands × diameter of single strand, in millimetres

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

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 mm^2 nominal cross-sectional area, the ratio..... 2.0.

(c) For cables rated at 1.1/1.1 kV with power conductors larger than 70 mm^2 nominal cross-sectional area, the ratio or value..... 3.0 or 0.547 Ω/km whichever is the lesser.

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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.

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TABLE 4

COLOURS AND ROTATIONAL SEQUENCE

Type No.	Rotational sequence of core colours
209*	red, white, blue
210*	red, white, blue
240	red, grey, white, grey, blue, grey
241*	red, black ‡, white, black‡, blue, black‡
245†	red, black‡, white, black‡, blue, black‡
260	red, grey, white, grey, blue, grey
275*	red, black‡, white, black‡, blue, black‡
280B*	red, black‡, white, black‡, blue, black‡

* The central pilot conductor insulation in all cases is coloured grey.

† The central pilot/control conductor insulations are coloured grey and numbered 1, 2 and 3.

‡ As the semiconductive covered earth conductors (Types 241, 245, 275 and 280B) are covered with semiconductive elastomer which is inherently black, it is not possible to assign the normal (green/yellow) earth colour identification to these conductors.

14 CRADLE SEPARATORS

14.1 Material

The material shall be of semiconductive elastomer (PCP, CSP or CPE) which shall be compatible with the insulation and comply with Tables 6 and 7.

14.2 Freedom to move and provision for cradle separator fingers

The cradle separators shall be such that the cores are free to move when the cable is flexed. Each finger of the cradle separator shall extend beyond a straight line joining the axis of power cores either side of the finger. The thickness of each finger shall be not less than 2.5 mm except for Type 245, where it shall be not less than is specified in Table 13.

15 SEMICONDUCTIVE ELASTOMER COVERING FOR INTERSTITIAL EARTH CONDUCTORS (TYPES 241, 245, 275 AND 280B ONLY)

15.1 Material

The material shall be of semiconductive elastomer (PCP, CSP or CPE) which shall be compatible with the insulation and comply with Tables 6 and 7.

15.2 Application

The semiconductive covering shall fit closely on, but not adhere to, the conductor.

15.3 Thickness

The average thickness of covering determined by the method specified for measurement of insulation thickness in AS/NZS 1660.2.1, shall be not less than the thickness specified (t_c) in Tables 12, 13, 15 and 16, as appropriate.

The minimum thickness at any point shall not fall below the specified thickness by more than 20 percent at the specified thickness plus 0.10 mm, that is,

$$\text{minimum thickness} = (0.8t_c - 0.10 \text{ mm}) \quad \ldots 3$$

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16 LAYING UP OF CORES

The cores of all cables 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 power core assembly, shall not exceed the following limits:

(a) For Type 210 cable ..... 9 times.

(b) For cables up to and including 3.3/3.3 kV with power conductors up to and including 70 mm^2, other than (a) above .....13 times.

(c) For cables with power conductors larger than 70 mm^2 and all cables rated above 3.3/3.3 kV .....16 times.

17 SEMICONDUCTIVE ELASTOMER SCREEN FOR CORE ASSEMBLY (TYPES 241, 245, 275 AND 280B ONLY)

17.1 Material

The material shall be of semiconductive elastomer (PCP, CSP or CPE) which shall be compatible with the insulation and comply with Tables 6 and 7.

17.2 Application

The semiconductive elastomer screen shall be applied over, but not adhere to, the laid-up core assembly so as to fill the remaining outer interstices and make continuous electrical contact with the exposed surface of the cores and the semiconductive covered earth conductors.

17.3 Thickness

The minimum thickness at any point of the screen, determined by the method specified in AS/NZS 1660.2.1 for the measurement of thickness of non-metallic sheath and the supplementary requirements specified in Clause 25.2, shall be not less than 0.3 mm.

The maximum thickness at any point shall not exceed the values given in Table 5.

TABLE 5

MAXIMUM THICKNESS OF SEMICONDUCTIVE SCREEN FOR CORE ASSEMBLY (Types 241, 245, 275 and 280B only)

Sheath thickness	Maximum thickness of elastomer screen for core assembly
mm	mm
≤7.0	1.5
>7.0 and ≤9.0	2.0
>9.0	3.0

NOTE: When establishing or measuring sheath thickness, the semiconductive elastomer screen is taken as part of the outer sheath (see Tables 12, 13, 15 and 16).

18 REINFORCEMENT FOR CORE ASSEMBLY (TYPES 241, 245, 275 AND 280B ONLY)

These types shall have a reinforcement binder comprising an open-weave polyamide monofilament tape or polyethylene terephthalate tape, applied over the semiconductive elastomer screened core assembly.

Alternatively, the reinforcement may comprise polyethylene terephthalate or aramid yarn (or equivalent), open-weave braid, or open-whipping in two contra-directional layers.

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Joints are permitted where renewal of tape pads or yarn spindles are required. Tape renewal shall involve an overlap of the new tape over the finishing end of the previous tape pad of at least 25 percent. There shall be not more than one yarn spindle renewal in any 300 mm length of cable.

19 INNER SHEATH (TYPE 260 ONLY)

19.1 Material

For Type 260, the sheath beneath the armour shall be GP–85–PCP, GP–90–CSP or GP–90–CPE in accordance with AS/NZS 3808.

NOTE: Where the zinc surface of the armour has become corroded, an adverse effect may occur on the ageing characteristics of CSP sheaths.

19.2 Application

The sheath shall fit closely over, but not adhere to, the laid-up core assembly and shall fill the outer interstices between the cores.

19.3 Thickness

The average thickness of inner sheath determined by the method specified in AS/NZS 1660.2.1 and Clause 25.2, shall be not less than the thickness (t_s) specified in Table 14. The minimum thickness at any point shall not fall below the specified thickness by more than 10 percent of the specified thickness plus 0.3 mm, that is,

$$\text{Minimum thickness} = (0.9t_s - 0.30 \text{ mm}) \quad \ldots 4$$

See Appendix B for the basis on which sheath thickness is determined.

19.4 Tests

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

20 PLIABLE ARMOUR (TYPE 260 ONLY)

20.1 Material

The armour shall comprise galvanized low carbon (mild) steel strands. Each strand shall consist of seven wires of appropriate diameter, as specified in Table 14. The wires shall comply with the requirements of AS/NZS 3863.

20.2 Application

The requisite number of strands shall be applied helically over the inner sheath to provide close cover, with a length of lay of not less than four and a half times nor more than six times the pitch circle diameter of the armour.

The direction of lay of the armour strands shall be opposite to that of the laid-up cores, that is, left hand.

See Appendix B for the basis on which armour size is determined.

21 OUTER SHEATH (ALL CABLES)

21.1 Material

The outer sheath of all types of cable shall be HD–85–PCP, HD–90–CSP or HD–90–CPE in accordance with AS/NZS 3808.

21.2 Colour

The recommended colour for the outer sheath is black.

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21.3 Application

The outer sheath of all cables shall be applied as follows:

(a) Types 209, 210, 240 and 260

The sheath shall fit closely over, but not adhere to, the core assembly or, in the case of Type 260, the armour.

Where the sheath is applied directly over the laid-up core assembly, it shall fill the outer interstices between the cores.

Where the sheath is applied in two layers (e.g. where a sheath reinforcement is provided), the layers shall make an effective bond.

(b) Types 241, 245, 275 and 280B

The sheath shall be applied over the reinforcement (see Clause 18) and make an effective bond to the underlying semiconductive elastomer screen layer (see Clause 17).

The surface of the sheath of Types 275 and 280B cables shall be free from curing-tape indentations.

21.4 Thickness

The average thickness of outer sheath determined by the method specified in AS/NZS 1660.2.1 and Clause 25.2, shall be not less than the thickness (t_s) specified in Tables 9 to 16 inclusive, as appropriate. The minimum thickness at any point shall not fall below the specified thickness by more than 10 percent of the specified thickness plus 0.3 mm, that is,

$$\text{minimum thickness} = (0.9t_s - 0.30 \text{ mm}) \quad \ldots 5$$

NOTES:

1 The sheath thickness need not be measured at the point of external identification marking.

2 Any open-weave reinforcement is taken to be part of the sheath.

3 See Appendix B for the basis on which sheath thickness is determined.

21.5 Tests

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

22 OPTIONAL OUTER SHEATH REINFORCEMENT (TYPES 209, 240 AND 260 ONLY)

22.1 Material

The use of reinforcement is optional. Where used, the outer sheath shall be reinforced using materials and methods as required by Clause 18.

NOTE: See Appendix A with regard to whether reinforcement is required.

22.2 Location of reinforcement

The reinforcement shall be located so that the thickness of the sheath over the reinforcement constitutes not less than 50 percent nor more than 80 percent of the total reinforced sheath thickness.

23 CONSTRUCTION AND DIMENSIONS (ALL CABLES)

The construction and dimensions of all cables shall be as specified in Figures 3 to 10 and Tables 9 to 16, as appropriate.

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TABLE 6

TESTS AND CRITERIA FOR SEMICONDUCTIVE ELASTOMER CRADLE SEPARATORS, COVERING ON EARTH CONDUCTORS, AND SCREEN FOR CORE ASSEMBLY

1	2	3	4
Test*	**Pass criteria**	**Category of test**	**Reference for test method**
A Mechanical tests without ageing on conditioned specimens:		Type	AS/NZS 1660.2.1
1 Tensile strength, minimum (MPa)	8.5		
2 Elongation at rupture, minimum (%)	200		
B Hot set test:		Sample	AS/NZS 1660.2.2
Duration—15 min			
Temperature—200 ±3°C			
Load—200 kPa			
1 Elongation under load, maximum (%)	175		
2 Residual elongation after cooling, maximum (%)	20		
C Mechanical test after ageing in an oven:		Type	AS/NZS 1660.2.2
Duration—240 h			
Temperature—120 ±3°C			
1 Tensile strength, actual minimum (MPa)	6.2		
2 Elongation at rupture, actual minimum (%)	50		
D Electrical tests: Volume resistivity, at 23 ±3°C (Ω.m)	<1 Ω.m	Type	Appendix C

* Due to difficulty of sample preparation, tests may be made on pressed sheets.

24 JOINTS IN COMPLETED CABLE LENGTHS

Except where specifically agreed between the purchaser and manufacturer, there shall be no joints permitted in a completed cable.

25 TESTS

25.1 Testing—General requirements

Cable shall comply with Table 7.

Type testing of a cable of designated type, voltage rating and conductor size shall qualify all cables of the same type and voltage rating with conductor sizes larger than the tested cable and shall also qualify such cable in lower voltage ratings for the range of conductor sizes.

NOTE: See Appendix A, Paragraph A2(k) for cables with smaller conductor sizes.

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TABLE 7

TESTS FOR COMPLETE CABLE ASSEMBLIES— PASS CRITERIA, CATEGORY AND REFERENCE

1	2	3	4	5
Test No.	**Test**	**Pass criteria**	**Category of test**	**Reference for test method**
1	All appropriate tests with the exception of resistance on conductors taken from the completed cable	As specified in AS/NZS 1125 for the appropriate conductor and Clause 7 of this Standard (AS/NZS 1802)		
2	Conductor examination and measurement of resistance including that of any composite screens	The conductor form, material and resistance shall comply with the appropriate requirements in AS/NZS 1125 (see Note 1) and Clauses 7, 8 and 12 of this Standard (AS/NZS 1802)	Routine	AS/NZS 1660.1
3	All appropriate tests on insulation taken from the completed cable	As specified in AS/NZS 3808		
4	All appropriate tests on inner and outer sheath taken from the completed cable	As specified in AS/NZS 3808 for the relevant sheath designation		
5	Extensibility test on central pilot core (Types 209, 210, 241, 275 and 280B cable only)	A sample of pilot core taken from the completed cable shall be capable of withstanding an elongation of not less than 15% without any conductive components fracturing	Type	AS/NZS 1125 (method as for elongation test)
6	Tests on textile reinforced semiconductive conductor screen taken from the completed cable or laboratory prepared samples:			
	(a) Measurement of volume resistivity	500 Ω.m max. at 23 ±3°C	Type	AS/NZS 1660.3
	(b) Measurement of thickness (where not in combination with extruded semiconductive screen)	As specified in Clause 9.5.2	Sample	—
7	Tests on extruded semiconductive conductor screen taken from the completed cable or laboratory prepared samples:			
	(a) Measurement of volume resistivity	200 Ω.m max. at 23 ±3°C	Type	AS/NZS 1660.3
	(b) Elongation at rupture after ageing:		Type	AS/NZS 1660.2.2 (method as for insulation)
	Duration—168 h Temperature—100 ±3°C minimum (%)	100		
	(c) Measurement of thickness	As specified in Clause 9.5	Sample	AS/NZS 1660.2.1
8	Measurement of thickness of insulation or covering taken from the completed cable	Compliance with Clause 10.3 or Clause 15.3	Sample	AS/NZS 1660.2.1 and Clause 25.2

(*continued*)

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TABLE 7 (*continued*)

1	2	3	4	5
Test No.	**Test**	**Pass criteria**	**Category of test**	**Reference for test method**
9	Tests on extruded semiconductive elastomer insulation screens:			
	(a) Measurement of volume resistivity at 23 ±3°C:			
	(i) insulation earth screens	<1 Ω.m	Type	AS/NZS 1660.3
	(ii) insulation stress relief screens	<200 Ω.m	Type	AS/NZS 1660.3
	(b) Elongation at rupture after ageing:			
	Duration—168 h Temperature—100 ±3°C minimum (%)	100	Type	AS/NZS 1660.2.2 (method as for insulation)
	(c) Strippability	The strip shall be capable of being peeled by hand from the insulation without: 1 Damaging the insulation. 2 Tearing in two. 3 Leaving semiconductive material which cannot be readily removed.	Sample	AS/NZS 1660.2.5
	(d) Adhesion test:			
	(i) Insulation earth screen	The force to remove should not exceed 80N and shall not be more than 125 N	Sample	AS/NZS 1660.2.5
	(ii) Insulation stress relief screen	The force to remove shall be not more than 125 N	Sample	AS/NZS 1660.2.5
	NOTE: Pre-treatment by heating may be required to strip material from insulation			
	(e) Measurement of thickness	Compliance with Clause 12.2.3 or Clause 12.3.3 as appropriate	Sample	AS/NZS 1660.2.1 and Clause 25.2
10	Tests on textile reinforced semiconductive tape screen (Types 209, 240 260 and 280B cable only):			
	(a) Measurement of volume resistivity	500 Ω.m max. at 23 ±3°C	Type	AS/NZS 1660.3
	(b) Measurement of thickness	Compliance with Clause 12.4.1 or Clause 12.5.1 as appropriate	Sample	—
11	Measurement of thickness of inner sheath	Compliance with Clause 19.3	Sample	AS/NZS 1660.2.1 and Clause 25.2
12	Measurement of armour dimensions	Compliance with Clause 20.1	Sample	AS/NZS 1660.1
13	Test for armour wires	Compliance with AS/NZS 3863	Type	AS/NZS 3863

(*continued*)

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TABLE 7 (*continued*)

1	2	3	4	5
Test No.	**Test**	**Pass criteria**	**Category of test**	**Reference for test method**
14	Measurement of thickness of outer sheath	Compliance with Clause 21.4	Sample	AS/NZS 1660.2.1 and Clause 25.2
15	Needle penetration test: Electrical conductivity tests on semiconductive components: (a) Test to verify 500 ma current flow on complete cable (Types 241, 245, 275, and 280B only) (b) Test to verify the capability to maintain a current flow (Types 241, 245, 275, and 280B only) (c) Other tests in Clause 25.4	Compliance with Clause 25.4	 Routine Routine Sample	 Clause 25.4.4 Clause 25.4.8 Clause 25.4
16	Combustion propagation test (a) Complete cable (see Notes 2 and 3) (b) Cradle separator or semiconductive covered earth conductor (Types 241, 245, 275 and 280B only) (c) Tests (a) and (b) above	 The sample shall be self-extinguishing within 30 s of removal of the flame. After all burning has ceased, the surface of the sample shall be wiped clean and the charred or affected portion shall not extend to within 50 mm of the lower edge of the clamp fitted at the top. The sample shall be self-extinguishing within 60 s of removal of the flame and the total length of cable component burnt or charred shall not exceed 250 mm During the tests, no falling particle shall ignite the tissue paper underlay	Type	AS/NZS 1660.5.6
17	High voltage a.c. test for 5 min	No breakdown	Routine	Clause 25.3

NOTES:

1 To correct the resistance for the short pitch of lay specified for Type 210 cables, the maximum resistance specified in AS/NZS 1125 should be multiplied by a factor of 1.02.

2 *Application to assessment of fire hazard* The test provides direct data on the likelihood of a single electric cable igniting and transmitting fire when exposed to a specified external ignition source. Fire, however, is a complex phenomenon and fire associated with a cable run is a function of the characteristics of the cable insulation material, the method of installation, and the environment in which it is used. Consequently, no single test can give a full assessment of the fire hazard under all conditions of fire that may apply. There needs to be a constant awareness of these interrelated factors and the effects of important variables in using this test to assess the fire hazard in any particular situation, for example, with coiled cables, special installation precautions may have to be taken as it cannot be assumed that a bunch of cables (e.g. when coiled) will behave in the same way as a single cable.

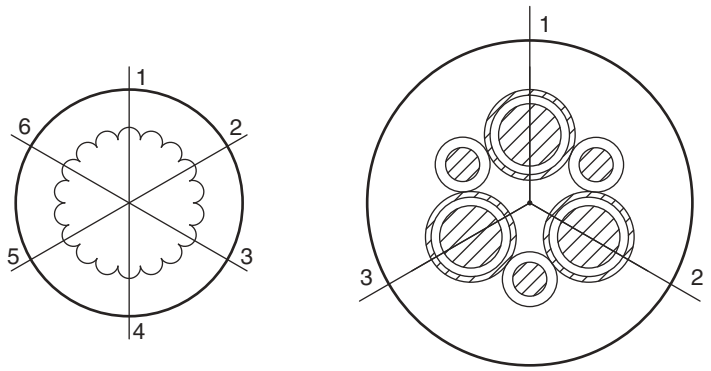
3 *Reporting of results* When reporting the results, the following cautionary note shall be added: Individual items of the test report should not be quoted in isolation as proof of product acceptability nor applied to directly assess performance under conditions other than as envisaged by the reference specification, for example, individual fire tests to prove an overall acceptable fire hazard level.

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25.2 Thickness of insulation, covering and sheath

The thickness of core insulation, covering, semiconductive elastomer insulation screens (if any) and inner sheath (if any) and outer sheath shall be determined by the method detailed in AS/NZS 1660.2.1.

To determine the average thickness of each such component, a representative specimen of cable shall have all conductors, composite screens (if any) and armour (if any) removed. The specimen shall be cut into a number of sections of equal size. The number of sections shall be not less than three. The exact number shall, however, be sufficient to provide a total of 18 measurements of all thicknesses on each component, such measurements being made at approximately equiangular displacements corresponding to the geometric minimum of the component. Examples of the places of measurement are shown in Figure 1.



6 measurements at 60°;
on each core at 3 sections
(a) Power core insulation

3 measurements at 120°;
at 6 sections
(b) Sheath of Types 240
or 241 cable

FIGURE 1 EXAMPLES OF PLACES OF MEASUREMENT

Any component within or bonded to the sheath, such as the semiconductive elastomer screen for core assembly (see Clause 17) shall be considered to be part of the sheath. The average of all the 18 measurements for each component shall then be calculated and be taken as the ‘thickness’ of the component for the purposes of this Standard. The smallest value of the 18 measurements taken for each component shall be taken as the ‘minimum thickness at any point’ of the component for the purpose of this Standard.

25.3 High voltage a.c. test for 5 minutes on power cores and pilot conductors

The cable shall be subjected to the following voltage test. The voltage shall be applied between the phase conductor and the core earth screens or earth conductors, and between pilot/control conductors and core earth screens or earth conductors. The composite screens or earth conductors and any armour shall be earthed.

The test shall be at ambient temperature, with an alternating voltage having a frequency in the range 40 Hz to 62 Hz. Its waveform shall approximate to a sine curve and have both half cycles reasonably alike (refer to AS 1931). The value of the applied voltage shall be as specified in Table 8. The voltage shall be increased gradually and maintained at the full value for 5 minutes.

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TABLE 8

HIGH VOLTAGE A.C. TEST VOLTAGES

1		2
Cable component or designation		**Test voltage kV r.m.s**
(a)	Cable component	
	Pilot conductors including central pilot/control conductors (regardless of cable designation)	1
(b)	Cable voltage designation, kV	
	1.1/1.1	4.2
	3.3/3.3	12
	6.6/6.6	22
	11/11	30

NOTE: The test voltages specified do not apply to cables terminated or fitted with plugs.

25.4 Electrical conductivity tests on semiconductive components

25.4.1 *General*

The purpose of these tests is to ensure a minimum conductance of the semiconductive elastomer components in the cable.

This test does not apply to the semiconductive insulation stress relief screens of Types 209, 240 and 260 cables.

25.4.2 *Test voltage and circuit to verify 500 mA immediate minimum current flow*

For the tests specified in Clauses 25.4.3, 25.4.4 and 25.4.5, the test voltage shall be 315 ±5 V r.m.s. at 40 Hz to 62 Hz, in series with a resistance of 424 ±5 Ω connected in the circuit.

25.4.3 *Requirements for all cable Types with a semiconductive cradle*

For this test, the length of test specimen is unimportant and can be as short as practicable.

The semiconductive cradle separator shall be removed from the cable and prepared for test as follows:

(a) Cradle with central pilot/control cores

Remove the central pilot core or one (or more) of the control cores and replace it with a tight fitting bare copper rod.

(b) Cradle without central pilot/control cores

Insert a bare copper spike, having a diameter of at least 1.2 mm, axially along the geometric centre of the cradle separator.

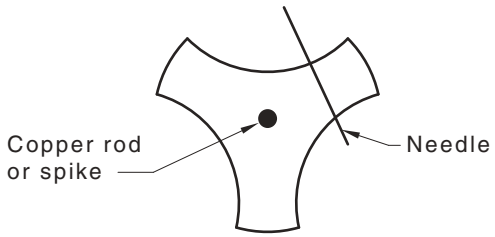
Approximately 60 s before application of the test voltage, a 1.2 mm diameter bare steel needle shall be pushed through one of the cradle separator fingers. The needle shall be positioned approximately midway between the bare copper rod or spike (as appropriate) and the edge of the cradle as shown in Figure 2.

The test voltage shall be applied between the copper rod or spike and the bare steel needle. The current which flows after application of the test voltage shall be measured and shall exceed 500 mA rms within 10 ms of the voltage being applied.

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If the time taken to reach the prescribed current flow exceeds 10 ms, the cable shall be deemed to have failed the test, unless two further tests are repeated on portions of the cradle separator, taken 150 mm and 300 mm respectively from the place of original measurement. If each of these additional tests produces a current flow exceeding 500 mA rms within 10 ms, the cable shall be deemed to have passed this test.

The application of voltage needs to be performed only once at the one needle location. Applying a voltage a second or more times at the same location will induce a higher current flow, but this is not the intent of the test. The specified minimum current flow needs to occur at the first application of voltage for each insertion of the steel needle.



Cradle separator

FIGURE 2 POSITION OF TEST NEEDLE

25.4.4 *Requirements for Types 241, 245, 275 and 280B cable*

For this test, a length of completed cable shall be used, the length of test specimen is not important and can be as short as practicable.

Approximately 60 s before the application of voltage, a 1.2 mm diameter bare steel needle shall be pushed perpendicularly through the outer sheath of the cable, the semiconductive elastomer screen, and insulation into a selected power conductor. The aim is to go through the thinnest part of the semiconductive elastomer screen for the core assembly, as close as practicable to the crest of the power core and at least 10 mm from the edge of the specimen.

The test voltage shall be applied between the selected power conductor and an adjacent earth conductor. The current which flows after application of the test voltage shall be measured and shall exceed 500 mA r.m.s. within 10 ms of the voltage being applied.

If the time to reach the prescribed current flow exceeds 10 ms, the cable shall be deemed to have failed the test, unless tests are repeated on each of the remaining two power cores. If each of these additional tests produces a current flow exceeding 500 mA r.m.s. within 10 ms of the voltage being applied, the cable shall be deemed to have passed this test.

The application of voltage shall be performed only once at the one needle location. Applying a voltage a second or more times at the same location will induce a higher current flow, but this is not the intent of the test. The specified minimum current flow needs to occur at the first application of voltage for each insertion of the needle.

25.4.5 *Requirements for Types 241, 245*

A length of semiconductive screened core shall be taken from the finished cable, the length of the test specimen to be at least 100 mm.

An electrical connection with the insulation earth screen is to be made at two locations by suitable means (e.g. loops of bare copper wire around the circumference) that allow a voltage to be applied along the length of the specimen over a distance not less than two times the diameter of the insulation earth screen, thus forming the electrodes for this test.

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The test voltage shall be applied between the two electrodes. The current which flows after application of the test voltage shall be measured and shall exceed 500 mA rms within 10 ms of the voltage being applied.

If the time to reach the prescribed current flow exceeds 10 ms, the cable shall be deemed to have failed the test, unless tests are performed on each of the remaining two power cores. If each of these additional tests produces a current flow exceeding 500 mA rms within 10 ms of the voltage being applied, the cable shall be deemed to have passed this test.

The application of voltage shall be performed only once for each specimen. Applying a voltage a second or more times at the same location will induce a higher current flow, but this is not the intent of the test. The specified minimum current flow needs to occur at the first application of voltage for each specimen.

25.4.6 *Test voltage and circuit to verify the capability to maintain a current flow*

For the tests specified in Clauses 25.4.7, 25.4.8, and 25.4.9, the test voltage shall be 315 ±5 V r.m.s. at 40 Hz to 62 Hz, in series with a resistance of 126 ± 5 Ω connected in the circuit.

NOTE: This circuit can generate up to 2500 mA r.m.s. depending on the resistance of the specimen.

25.4.7 *Requirement for all cables with a semiconductive cradle*

Using a new specimen and the same preparation method as described in Clause 25.4.3, the test voltage shall be applied between the copper rod or spike and the bare steel needle. The current which flows after application of the test voltage shall be measured and maintained for at least 15 s. The current measured shall, at no time during the test, be less than 500 mA r.m.s.

25.4.8 *Requirement for Types 241, 245, 275, and 280B*

Using a new specimen and the same preparation method as described in Clause 25.4.4, the test voltage shall be applied between the power conductor and an adjacent earth conductor. The current which flows after application of the test voltage shall be measured and maintained for at least 15 s. The current measured shall, at no time during the test, be less than 500 mA r.m.s.

25.4.9 *Requirement for Types 241, 245*

Using a new specimen and the same preparation method as described in Clause 25.4.5, the test voltage shall be applied between the two electrodes. The current which flows after application of the test voltage shall be measured and maintained for at least 15 s. The current measured shall, at no time during the test, be less than 500 mA r.m.s.

26 MARKING (ALL CABLES)

26.1 Internal

All cables shall be durably and legibly marked with the manufacturer’s name or registered trademark, numbers to indicate the year of manufacture, and voltage designation (see Clause 4). The marking shall consist of printing on one or more power or earth cores or of printing on a non-hygroscopic tape and shall appear throughout the entire length of the cable at length intervals of not more than the following:

(a) For cables incorporating power conductors of 16 mm^2 nominal cross-sectional area or larger ..... 1 m.

(b) For cables incorporating power conductors less than 16 mm^2 nominal cross-sectional area .....300 mm.

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26.2 External

Cables shall be durably and legibly marked on the external sheath by pressed lettering or other durable means and numbers at length intervals not greater than 10 m. The letters and numbers shall have a nominal height of 6 mm and, where pressed lettering is used, with a depth not less than 0.4 mm or more than 0.8 mm. The following information shall be marked:

(a) A registered name or registered mark which enables the manufacturer or supplier to be identified.

(b) Designation of insulation and sheath.

(c) The type number of the cable and, except for Types 210, 275 and 280B, the voltage designation, e.g. Type 209.11 (see Tables 9 to 16 inclusive).

(d) Year of manufacture.

(e) Cross-sectional area of main conductor.

26.3 Marking of cable drums

Every drum of cable shall be durably and legibly marked with the following information:

(a) A registered name or registered mark which enables the manufacturer or supplier to be identified.

(b) Drum reference number.

(c) Order number.

(d) Cable type number and voltage rating.

(e) Length of cable, in metres.

(f) Gross mass of cable including drum, in kilograms.

(g) Size of main conductors, in square millimetres.

(h) Specified maximum resistance of pilot/control conductor, where appropriate, in ohms per hundred metres.

(i) Designation of insulation and sheath.

NOTE: Manufacturers making a statement of compliance with this Australian/New Zealand Standard on a product, packaging, or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

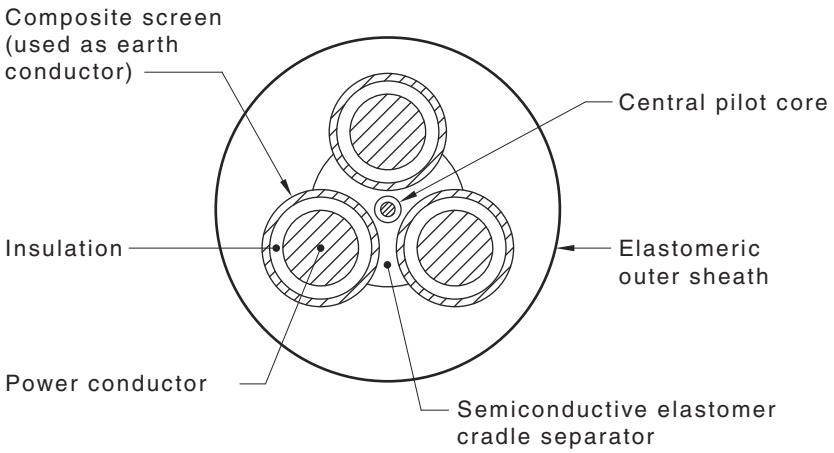
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27 FIGURES OF CONSTRUCTION AND TABLES OF DIMENSIONS

Figures 3 to 10 and Tables 9 to 16 give the construction and dimensions, respectively, of the following types of cable:

Type	Figure	Table
209	3	9
210	4	10
240	5	11
241	6	12
245	7	13
260	8	14
275	9	15
280B	10	16

TYPE 209 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator containing a central pilot core	8 and 14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• a conductor screen for cable 3.3/3.3 kV and above	9
• insulation	10
• screen	
a tape and composite screen for 1.1/1.1 kV cable; or	11 and 12
semiconductive elastomer or semiconductive tape and composite screen for cables 3.3/3.3 kV and above	12
The three power cores laid up around the cradle separator	16
Outer sheath of heavy duty elastomer that also fills the outer interstices of the laid-up core assembly	21
Optional sheath reinforcement (within sheath)	22

FIGURE 3 CONSTRUCTION OF TYPE 209—COMPOSITE SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

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TABLE 9

DIMENSIONS OF TYPE 209—COMPOSITE SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

1	2	3	4	5	6
Type	Voltage designation	Power conductor			Sheath thickness (t_s)
		Nominal cross-sectional area	Insulation thickness (t_i)	Composite screen strand size	
	kV	mm^2	mm	No./mm	mm
209.1	1.1/1.1	6	1.5	7/0.25	3.8
		10	1.5	7/0.25	3.8
		16	1.6	7/0.25	4.0
		25	1.6	7/0.25	4.3
		35	1.6	7/0.25	4.6
		50	1.7	7/0.25	5.0
		70	1.8	7/0.25	5.4
		95	2.0	7/0.25	6.0
		120	2.1	7/0.25	6.4
		150	2.3	7/0.25	6.9
		185	2.5	7/0.30	7.4
		240	2.8	7/0.30	8.2
		300	3.0	7/0.40	8.8
209.3	3.3/3.3	16	3.0	7/0.25	5.3
		25	3.0	7/0.25	5.6
		35	3.0	7/0.25	5.9
		50	3.0	7/0.25	6.3
		70	3.0	7/0.25	6.6
		95	3.0	7/0.25	7.1
		120	3.0	7/0.30	7.4
		150	3.0	7/0.30	7.8
		185	3.0	7/0.40	8.2
		240	3.0	7/0.40	8.8
		300	3.0	7/0.50	9.0
209.6	6.6/6.6	16	5.0	7/0.25	6.4
		25	5.0	7/0.25	6.7
		35	5.0	7/0.25	7.0
		50	5.0	7/0.25	7.3
		70	5.0	7/0.25	7.7
		95	5.0	7/0.30	8.1

(*continued*)

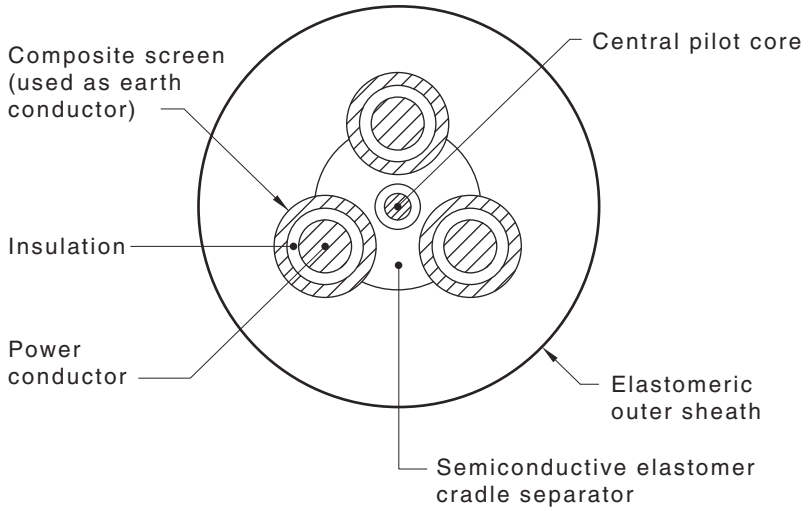
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TABLE 9 (*continued*)

1	2	3	4	5	6
		Power conductor			
Type	Voltage designation	Nominal cross-sectional area	Insulation thickness (t_i)	Composite screen strand size	Sheath thickness (t_s)
	kV	mm^2	mm	No./mm	mm
		120	5.0	7/0.30	8.5
		150	5.0	7/0.40	8.9
		185	5.0	7/0.40	9.0
		240	5.0	7/0.40	9.0
		300	5.0	7/0.50	9.0
209.11	11/11	25	7.6	7/0.25	8.1
		35	7.6	7/0.30	8.4
		50	7.6	7/0.30	8.7
		70	7.6	7/0.30	9.0
		95	7.6	7/0.40	9.0
		120	7.6	7/0.40	9.0
		150	7.6	7/0.40	9.0
		185	7.6	7/0.40	9.0
		240	7.6	7/0.50	9.0

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TYPE 210 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator containing a central pilot core	8 and 14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• insulation	10
• a tape and composite screen	11 and 12
The three power cores laid up around the cradle separator	16
Outer sheath of heavy duty elastomer that also fills the outer interstices of the laid-up core assembly	21

Voltage designation: 1.1/1.1 kV (see Note)

NOTE: Certain regulatory authorities limit the use of this cable to 250/250 V.

FIGURE 4 CONSTRUCTION OF TYPE 210—COMPOSITE SCREENED CABLE FOR HAND-HELD BORING MACHINES

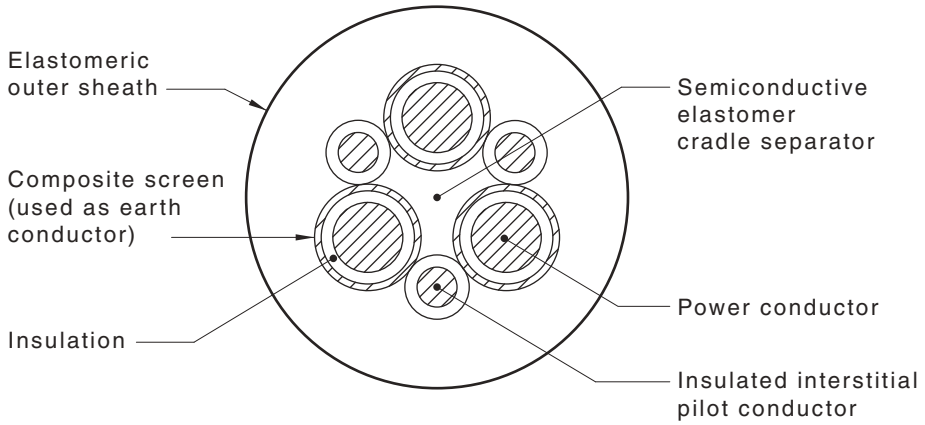
TABLE 10

DIMENSIONS OF TYPE 210

Power conductor			Sheath thickness (t_s)
Nominal cross-sectional area	Insulation thickness (t_i)	Composite screen strand size	
mm^2	mm	No./mm	mm
1.5	1.4	7/0.25	3.0
2.5	1.5	7/0.25	3.0

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TYPE 240 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator	14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• a conductor screen for cable 3.3/3.3 kV and above	9
• insulation	10
• screen	
a tape and composite screen for 1.1/1.1 kV cable	11 and 12
semiconductive elastomer or semiconductive tape and composite screen for cables 3.3/3.3 kV and above	12
The three power cores laid up around the cradle separator	16
Three elastomer insulated and taped pilot conductors disposed one into each of the outer interstices of the laid-up power core assembly	7, 10 and 11
Outer sheath of heavy duty elastomer that also fills the outer interstices of the laid-up core assembly	21
Optional sheath reinforcement (within sheath)	22

FIGURE 5 CONSTRUCTION OF TYPE 240—COMPOSITE SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

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TABLE 11

DIMENSIONS OF TYPE 240—COMPOSITE SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

1	2	3	4	5	6	7	8
Type	Voltage designation	Power conductor			Pilot conductor		Sheath thickness (t_s)
		Nominal cross-sectional area	Insulation thickness (t_i)	Composite screen strand size	Minimum number and nominal diameter of wires	Insulation thickness (t_i)	
	kV	mm^2	mm	No./mm	No./mm	mm	mm
240.1	1.1/1.1	6	1.5	7/0.25	15/0.30	1.0	3.8
		10	1.5	7/0.25	24/0.30	1.0	3.8
		16	1.6	7/0.25	39/0.30	1.0	4.0
		25	1.6	7/0.25	63/0.30	1.2	4.3
		35	1.6	7/0.25	87/0.30	1.2	4.6
		50	1.7	7/0.25	114/0.30	1.2	5.0
		70	1.8	7/0.25	36/0.67	1.2	5.4
		95	2.0	7/0.25	36/0.67	1.2	6.0
		120	2.1	7/0.25	39/0.67	1.4	6.4
		150	2.3	7/0.25	48/0.67	1.4	6.9
		180	2.5	7/0.30	63/0.67	1.4	7.4
		240	2.8	7/0.30	77/0.67	1.6	8.2
		300	3.0	7/0.40	98/0.67	1.6	8.8
240.3	3.3/3.3	16	3.0	7/0.25	39/0.30	1.4	5.3
		25	3.0	7/0.25	63/0.30	1.4	5.6
		35	3.0	7/0.25	87/0.30	1.4	5.9
		50	3.0	7/0.25	114/0.30	1.4	6.3
		70	3.0	7/0.25	36/0.67	1.4	6.6
		95	3.0	7/0.25	36/0.67	1.4	7.1
		120	3.0	7/0.30	39/0.67	1.6	7.4
		150	3.0	7/0.30	48/0.67	1.6	7.8
		185	3.0	7/0.40	63/0.67	1.8	8.2
		240	3.0	7/0.40	77/0.67	1.8	8.8
		300	3.0	7/0.50	98/0.67	1.8	9.0
240.6	6.6/6.6	16	5.0	7/0.25	39/0.30	1.4	6.4
		25	5.0	7/0.25	63/0.30	1.4	6.7
		35	5.0	7/0.25	87/0.30	1.6	7.0
		50	5.0	7/0.25	114/0.30	1.6	7.3
		70	5.0	7/0.25	36/0.67	1.6	7.7
		95	5.0	7/0.30	36/0.67	1.6	8.1
		120	5.0	7/0.30	39/0.67	1.8	8.5
		150	5.0	7/0.40	48/0.67	1.8	8.9

(*continued*)

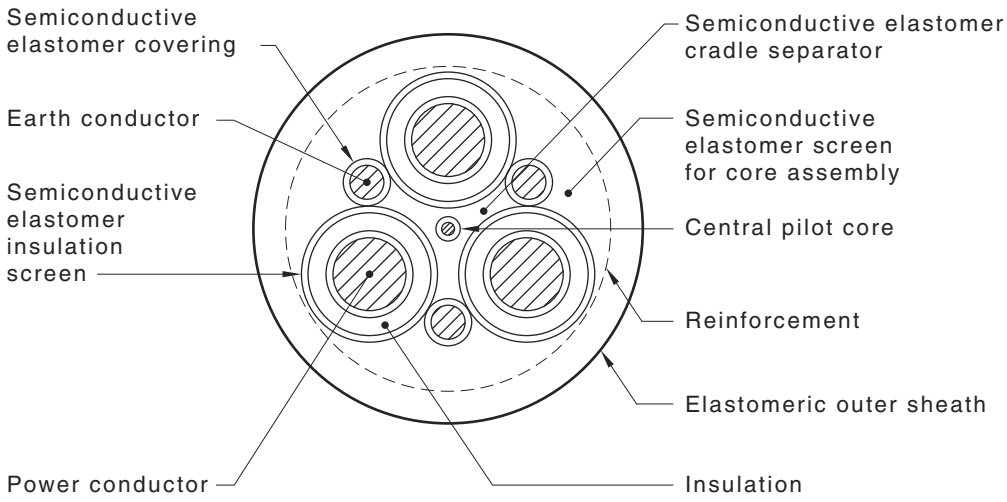
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TABLE 11 (*continued*)

1	2	3	4	5	6	7	8
		Power conductor			Pilot conductor		
Type	Voltage designation	Nominal cross-sectional area	Insulation thickness (t_i)	Composite screen strand size	Minimum number and nominal diameter of wires	Insulation thickness (t_i)	Sheath thickness (t_s)
	kV	mm^2	mm	No./mm	No./mm	mm	mm
		185	5.0	7/0.40	63/0.67	1.8	9.0
		240	5.0	7/0.40	77/0.67	1.8	9.0
		300	5.0	7/0.50	98/0.67	1.8	9.0
240.11	11/11	25	7.6	7/0.25	63/0.30	2.0	8.1
		35	7.6	7/0.30	87/0.30	2.0	8.4
		50	7.6	7/0.30	114/0.30	2.0	8.7
		70	7.6	7/0.30	36/0.67	2.0	9.0
		95	7.6	7/0.40	36/0.67	2.0	9.0
		120	7.6	7/0.40	39/0.67	2.2	9.0
		150	7.6	7/0.40	48/0.67	2.2	9.0
		185	7.6	7/0.40	63/0.67	2.2	9.0
		240	7.6	7/0.50	77/0.67	2.2	9.0

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TYPE 241 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator containing a central pilot core	8 and 14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• a conductor screen for cable 3.3/3.3 kV and above	9
• insulation	10
• a semiconductive elastomer insulation earth screen	12
The three power cores laid up around the cradle separator	16
Three semiconductive elastomer covered earth conductors disposed one into each of the outer interstices of the laid-up power core assembly	7 and 15
Semiconductive elastomer filling and screen for laid-up core assembly	17
Reinforcement for core assembly	18
Outer sheath of heavy duty elastomer	21

FIGURE 6 CONSTRUCTION OF TYPE 241—SEMICONDUCTIVE EARTH SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

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TABLE 12

DIMENSIONS OF TYPE 241—SEMICONDUCTIVE EARTH SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

1	2	3	4	5	6	7
Type	Voltage designation	Power conductor		Earth conductor		Sheath thickness including the semi-conductive screen over core assembly (t_s)
		Nominal cross-sectional area	Insulation thickness (t_i)	Minimum number and nominal diameter of wires	Semi-conductive covering thickness (t_c)	
	kV	mm^2	mm	No./mm	mm	mm
241.1	1.1/1.1	6	1.5	15/0.30	1.0	3.8
		10	1.5	24/0.30	1.0	3.8
		16	1.6	39/0.30	1.0	3.9
		25	1.6	63/0.30	1.0	4.2
		35	1.6	87/0.30	1.0	4.4
		50	1.7	114/0.30	1.0	4.9
		70	1.8	36/0.67	1.0	5.3
		95	2.0	36/0.67	1.0	5.8
		120	2.1	39/0.67	1.2	6.3
		150	2.3	48/0.67	1.2	6.7
		185	2.5	63/0.67	1.4	7.3
		240	2.8	77/0.67	1.4	8.0
		300	3.0	98/0.67	1.4	8.7
241.3	3.3/3.3	16	3.0	39/0.30	1.0	5.0
		25	3.0	63/0.30	1.0	5.3
		35	3.0	87/0.30	1.0	5.6
		50	3.0	114/0.30	1.2	6.0
		70	3.0	36/0.67	1.2	6.4
		95	3.0	45/0.67	1.2	6.8
		120	3.0	57/0.67	1.2	7.2
		150	3.0	77/0.67	1.2	7.6
		185	3.0	91/0.67	1.4	8.0
		240	3.0	112/0.67	1.4	8.6
		300	3.0	144/0.67	1.4	9.0
241.6	6.6/6.6	16	5.0	39/0.30	1.4	6.1
		25	5.0	63/0.30	1.4	6.4
		35	5.0	87/0.30	1.4	6.7
		50	5.0	114/0.30	1.4	7.1
		70	5.0	36/0.67	1.4	7.4
		95	5.0	45/0.67	1.4	7.9
		120	5.0	57/0.67	1.4	8.3

(*continued*)

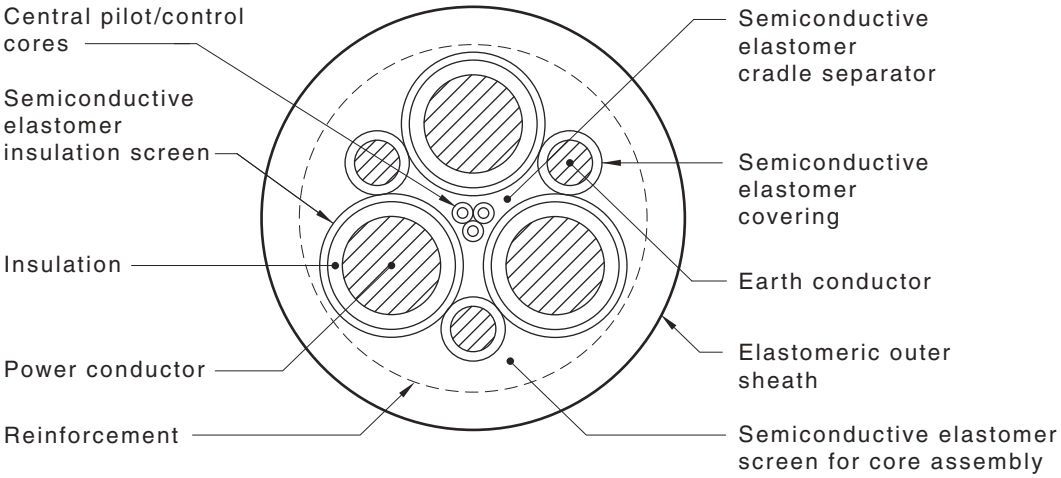
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TABLE 12 (*continued*)

1	2	3	4	5	6	7
		Power conductor		Earth conductor		Sheath thickness including the semi-conductive screen over core assembly (t_s)
Type	Voltage designation	Nominal cross-sectional area	Insulation thickness (t_i)	Minimum number and nominal diameter of wires	Semi-conductive covering thickness (t_c)	
	kV	mm^2	mm	No./mm	mm	mm
		150	5.0	77/0.67	1.4	8.6
		185	5.0	91/0.67	1.4	9.0
		240	5.0	112/0.67	1.4	9.0
		300	5.0	144/0.67	1.4	9.0
241.11	11/11	25	7.6	63/0.30	1.8	7.8
		35	7.6	87/0.30	1.8	8.1
		50	7.6	114/0.30	1.8	8.5
		70	7.6	36/0.67	1.8	8.9
		95	7.6	45/0.67	1.8	9.0
		120	7.6	57/0.67	1.8	9.0
		150	7.6	77/0.67	1.8	9.0
		185	7.6	91/0.67	1.8	9.0
		240	7.6	112/0.67	1.8	9.0

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TYPE 245 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator containing three pilot/control cores	8 and 14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• a conductor screen for cable 3.3/3.3 kV cable only	9
• insulation	10
• a semiconductive elastomer insulation earth screen	12
The three power cores laid up around the cradle separator	16
Three semiconductive elastomer covered earth conductors disposed one into each of the outer interstices of the laid-up power core assembly	7 and 15
Semiconductive elastomer filling and screen for laid-up core assembly	17
Reinforcement for core assembly	18
Outer sheath of heavy duty elastomer	21

FIGURE 7 CONSTRUCTION OF TYPE 245—SEMICONDUCTIVE EARTH SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

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TABLE 13

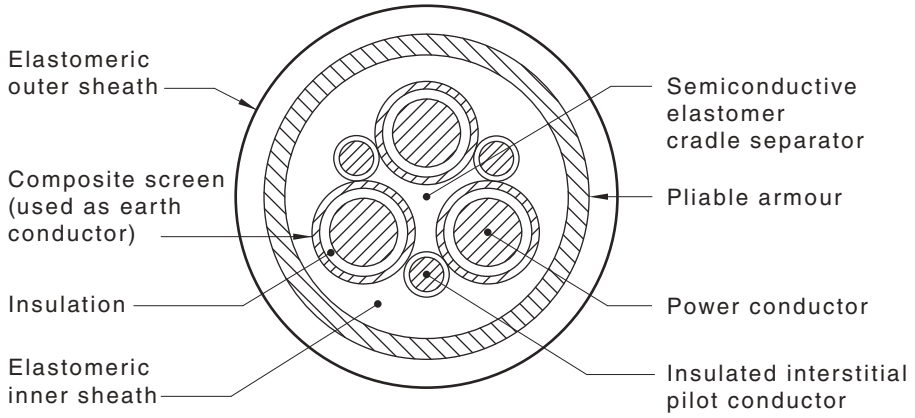
DIMENSIONS OF TYPE 245—SEMICONDUCTIVE EARTH SCREENED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

Type	Voltage designation	Power conductor		Earth conductor		Semi conductive cradle finger thickness (t_f)	Sheath thickness including the semi-conductive screen over core assembly (t_s)
		Nominal cross-sectional area	Insulation thickness (t_i)	Minimum number and nominal diameter of wires	Semiconductive covering thickness (t_c)		
	kV	mm^2	mm	No./mm	mm	mm	mm
245.1	1.1/1.1kV	16	2.0	39/0.30	1.8*	6.2	4.1
		25	1.6	63/0.30	1.8*	5.8	4.2
		35	1.6	87/0.30	1.4*	5.6	4.4
		50	1.7	114/0.30	1.0	5.4	4.8
		70	1.8	36/0.67	1.0	5.1	5.1
		95	2.0	36/0.67	1.0	4.8	5.6
		120	2.1	36/0.67	1.2	4.7	6.0
		150	2.3	48/0.67	1.2	4.2	6.3
		185	2.5	63/0.67	1.4	4.0	6.8
245.3	3.3/3.3kV	25	3.0	63/0.30	1.5*	5.4	5.2
		35	3.0	87/0.30	1.0	5.2	5.4
		50	3.0	114/0.30	1.0	5.0	5.7
		70	3.0	36/0.67	1.2	4.7	6.0
		95	3.0	45/0.67	1.2	4.4	6.4
		120	3.0	57/0.67	1.2	4.3	6.7
		150	3.0	77/0.67	1.2	3.9	7.0
		185	3.0	91/0.67	1.4	3.8	7.4

* Thickness of covering over earth built up to ensure cradle fingers meet the requirements of Clause 14.2.

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TYPE 260 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator	14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• a conductor screen for cable 3.3/3.3 kV and above	9
• insulation	10
• screen	
tape and composite screen for 1.1/1.1 kV cable, or	11 and 12
semiconductive elastomer or semiconductive tape and composite screens for cables 3.3/3.3 kV and above	12
The three power cores laid up around the cradle separator	16
Three elastomer insulated and taped pilot conductors disposed one into each of the outer interstices of the laid-up power core assembly	7, 10 and 11
Inner sheath of heavy duty elastomer that also fills the outer interstices of the laid-up core assembly	19
Pliable armour	19
Outer sheath of heavy duty elastomer	21
Optional sheath reinforcement (within outer sheath)	22

FIGURE 8 CONSTRUCTION OF TYPE 260—COMPOSITE SCREENED AND PLIABLE ARMOURED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

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TABLE 14

DIMENSIONS OF TYPE 260—COMPOSITE SCREENED AND PLIABLE ARMOURED CABLE FOR GENERAL USE (EXCLUDING SHUTTLE CARS)

1	2	3	4	5	6	7	8	9	10
Type	Voltage designation	Power conductor			Pilot conductor		Sheath thickness (t_s)		Pliable armour, number, and nominal diameter of wires
		Nominal cross-sectional area	Insulation thickness (t_s)	Composite screen strand size	Minimum number and nominal diameter of wires	Insulation thickness (t_i)	Inner	Outer	
	kV	mm^2	mm	No./mm	No./mm	mm	mm	mm	No./mm
260.1	1.1/1.1	6	1.5	7/0.25	15/0.30	1.0	2.0	3.8	7/0.45
		10	1.5	7/0.25	24/0.30	1.0	2.0	3.8	7/0.45
		16	1.6	7/0.25	39/0.30	1.0	2.5	4.0	7/0.71
		25	1.6	7/0.25	63/0.30	1.2	2.5	4.3	7/0.71
		35	1.6	7/0.25	87/0.30	1.2	2.5	4.6	7/0.71
		50	1.7	7/0.25	114/0.30	1.2	2.5	5.0	7/0.71
		70	1.8	7/0.25	36/0.67	1.2	2.5	5.4	7/0.71
		95	2.0	7/0.25	36/0.67	1.2	3.5	6.0	7/0.90
		120	2.1	7/0.25	39/0.67	1.4	3.5	6.4	7/0.90
		150	2.3	7/0.25	48/0.67	1.4	3.5	6.9	7/0.90
		185	2.5	7/0.30	63/0.67	1.4	3.5	7.4	7/0.90
		240	2.8	7/0.30	77/0.67	1.6	4.5	8.2	7/1.25
		300	3.0	7/0.40	98/0.67	1.6	4.5	8.8	7/1.25

(*continued*)

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TABLE 14 (*continued*)

1	2	3	4	5	6	7	8	9	10
Type	Voltage designation	Power conductor			Pilot conductor		Sheath thickness (t_s)		Pliable armour, number, and nominal diameter of wires
		Nominal cross-sectional area	Insulation thickness (t_s)	Composite screen strand size	Minimum number and nominal diameter of wires	Insulation thickness (t_i)	Inner	Outer	
	kV	mm^2	mm	No./mm	No./mm	mm	mm	mm	No./mm
260.3	3.3/3.3	16	3.0	7/0.25	39/0.30	1.4	2.5	5.3	7/0.71
		25	3.0	7/0.25	63/0.30	1.4	2.5	5.6	7/0.71
		35	3.0	7/0.25	87/0.30	1.4	3.5	5.9	7/0.90
		50	3.0	7/0.25	114/0.30	1.4	3.5	6.3	7/0.90
		70	3.0	7/0.25	36/0.67	1.4	3.5	6.6	7/0.90
		95	3.0	7/0.25	36/0.67	1.4	3.5	7.1	7/0.90
		120	3.0	7/0.30	39/0.67	1.6	3.5	7.4	7/0.90
		150	3.0	7/0.30	48/0.67	1.6	4.5	7.8	7/1.25
		185	3.0	7/0.40	63/0.67	1.8	4.5	8.2	7/1.25
		240	3.0	7/0.40	77/0.67	1.8	4.5	8.8	7/1.25
		300	3.0	7/0.50	98/0.67	1.8	4.5	9.0	7/1.25
260.6	6.6/6.6	16	5.0	7/0.25	39/0.30	1.4	3.5	6.4	7/0.90
		25	5.0	7/0.25	63/0.30	1.4	3.5	6.7	7/0.90
		35	5.0	7/0.25	87/0.30	1.6	3.5	7.0	7/0.90
		50	5.0	7/0.25	114/0.30	1.6	3.5	7.3	7/0.90

(*continued*)

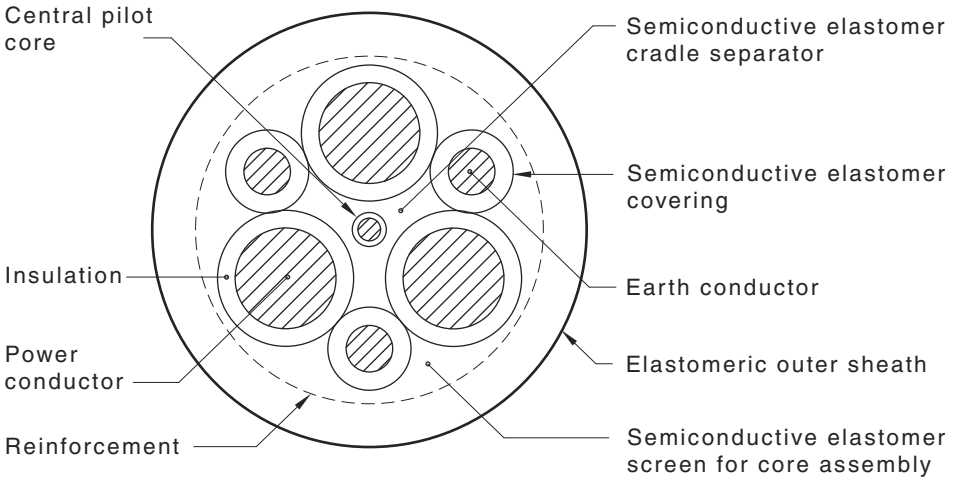
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TABLE 14 (*continued*)

1	2	3	4	5	6	7	8	9	10
Type	Voltage designation	Power conductor			Pilot conductor		Sheath thickness (t_s)		Pliable armour, number, and nominal diameter of wires
		Nominal cross-sectional area	Insulation thickness (t_s)	Composite screen strand size	Minimum number and nominal diameter of wires	Insulation thickness (t_i)	Inner	Outer	
	kV	mm^2	mm	No./mm	No./mm	mm	mm	mm	No./mm
		70	5.0	7/0.25	36/0.67	1.6	4.5	7.7	7/1.25
		95	5.0	7/0.30	36/0.67	1.6	4.5	8.1	7/1.25
		120	5.0	7/0.30	39/0.67	1.8	4.5	8.5	7/1.25
		150	5.0	7/0.40	48/0.67	1.8	4.5	8.9	7/1.25
		185	5.0	7/0.40	63/0.67	1.8	4.5	9.0	7/1.25
		240	5.0	7/0.40	77/0.67	1.8	4.5	9.0	7/1.25
		300	5.0	7/0.50	98/0.67	1.8	4.5	9.0	7/1.25
260.11	11/11	25	7.6	7/0.25	63/0.30	2.0	4.5	8.1	7/1.25
		35	7.6	7/0.30	87/0.30	2.0	4.5	8.4	7/1.25
		50	7.6	7/0.30	114/0.30	2.0	4.5	8.7	7/1.25
		70	7.6	7/0.30	36/0.67	2.0	4.5	9.0	7/1.25
		95	7.6	7/0.40	36/0.67	2.0	4.5	9.0	7/1.25
		120	7.6	7/0.40	39/0.67	2.2	4.5	9.0	7/1.25
		150	7.6	7/0.40	48/0.67	2.2	4.5	9.0	7/1.25
		185	7.6	7/0.40	63/0.67	2.2	4.5	9.0	7/1.25
		240	7.6	7/0.50	77/0.67	2.2	4.5	9.0	7/1.25

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TYPE 275 SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer separator containing a central pilot core	8 and 14
Three power cores of equal cross-sectional area, each comprising—	
• a conductor	7
• insulation	10
The three power cores laid up around the cradle separator	16
Three semiconductive elastomer covered earth conductors disposed one into each of the outer interstice of the laid-up power core assembly	7 and 15
Semiconductive elastomer filling and screen for laid-up core assembly	17
Reinforcement for core assembly	18
Outer sheath of heavy duty elastomer	21

Voltage designation: 1.1/1.1 kV

FIGURE 9 CONSTRUCTION OF TYPE 275—CIRCULAR A.C. SHUTTLE CAR CABLE

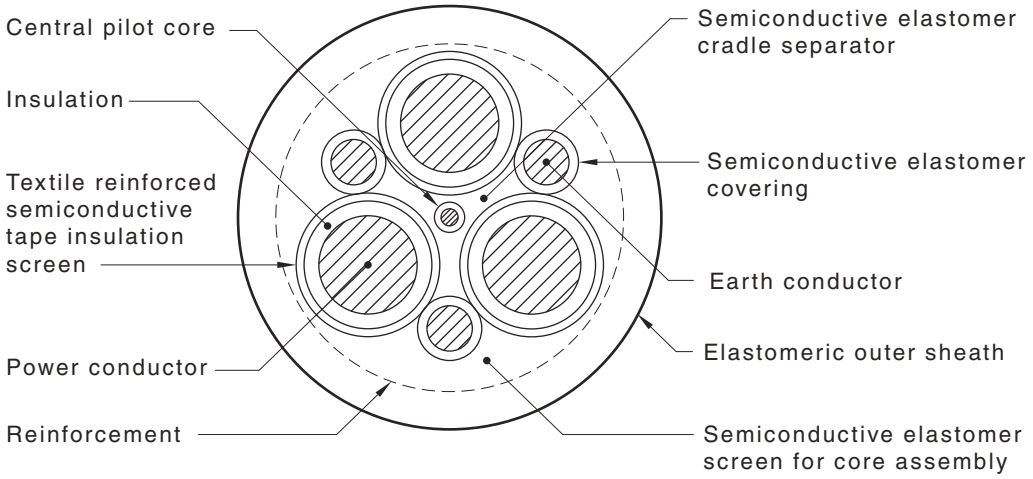
TABLE 15

DIMENSIONS OF TYPE 275—CIRCULAR A.C. SHUTTLE CAR CABLE
Voltage designation: 1.1/1.1 kV

Power conductor		Earth conductor		Sheath thickness including the semiconductive screen over core assembly (t_s)
Nominal area	Insulation thickness (t_i)	Minimum number and nominal diameter of wires	Semi-conductive covering thickness (t_c)	
mm^2	mm	No./mm	mm	mm
16	1.6	57/0.30	1.0	3.8
25	1.6	54/0.40	1.0	4.0
35	1.6	75/0.40	1.0	4.3
50	1.7	99/0.40	1.0	4.7

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TYPE 280B SECTIONAL DIAGRAM



Construction (from the centre outward)	Clause reference for requirements
Semiconductive elastomer cradle separator containing a central pilot core	8 and 14
Three power cores of equal cross-sectional area, each comprising—	7
• a conductor	10
• insulation	
• textile reinforced semiconductive tape insulation earth screen	12
The three power cores laid up around the cradle separator	16
Three semiconductive elastomer covered earth conductors disposed one into each of the outer interstice of the laid-up power core assembly	7 and 15
Semiconductive elastomer filling and screen for laid-up core assembly	17
Reinforcement for core assembly	18
Outer sheath of heavy duty elastomer	21

Voltage designation: 1.1/1.1 kV

FIGURE 10 CONSTRUCTION OF TYPE 280B—SEMICONDUCTIVE SCREENED CABLE FOR GENERAL USE (INCLUDING SHUTTLE CARS)

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TABLE 16

DIMENSIONS OF TYPE 280B—SEMICONDUCTIVE SCREENED CABLE FOR GENERAL USE (INCLUDING SHUTTLE CARS) Voltage designation: 1.1/1.1 kV

1	2	3	4	5
Power conductor		Earth conductor		Sheath thickness including the semiconductive screen over core assembly (t_s)
Nominal cross-sectional area	Insulation thickness (t_i)	Minimum number and nominal diameter of wires	Semiconductive covering thickness (t_c)	
mm^2	mm	No./mm	mm	mm
6	1.5	24/0.30	1.0	3.8
10	1.5	36/0.30	1.0	3.8
16	1.6	57/0.30	1.0	3.8
25	1.6	54/0.40	1.0	4.1
35	1.6	75/0.40	1.0	4.4
50	1.7	99/0.40	1.0	4.8
70	1.8	36/0.67	1.0	5.2
95	2.0	36/0.67	1.0	5.8
120	2.1	39/0.67	1.2	6.2
150	2.3	51/0.67	1.2	6.7
185	2.5	63/0.67	1.4	7.2
240	2.8	77/0.67	1.4	8.0
300	3.0	98/0.67	1.4	8.6

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APPENDIX A

PURCHASING GUIDELINES

(Informative)

A1 GENERAL

Australian/New Zealand Standards are intended to include the technical requirements for relevant products, but do not purport to comprise all the necessary provisions of a contract. This appendix contains advice and recommendations on the information to be supplied by the purchaser at the time of enquiry or order.

A2 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser should supply the following information at the time of enquiry and order:

(a) The number of this Australian/New Zealand Standard, i.e. AS/NZS 1802.

(b) The type of cable required and its intended use in relation to the nature of the mine, for example, Type 209 for continuous miner, Type 275 for underground coal mine shuttle car.

(c) The voltage designation of the cable (see Clause 4 and Table 1).

(d) The nominal cross-sectional area.

(e) The required maximum operating temperature of the cable due to ambient temperature and heating effect of current. If this is not known, the manufacturer should be informed of the maximum continuous current rating to be assigned to the cable and the maximum ambient temperature in which the cable will be used.

(f) The type of outer sheath, e.g. PCP, CSP or CPE (see Clause 21.1).

(g) Whether for Types 209, 240 and 260, reinforcement is required in the outer sheath (see Clause 22) and, if so, what type.

(h) Whether for 3.3/3.3 kV and higher rated Types 209, 240 and 260, textile-reinforced semiconductive tape or semiconductive elastomer conductor and insulation screens are required.

(i) For cables incorporating a central pilot conductor, the maximum required resistance per unit length of the conductor if the value specified in Clause 8 is too great for the particular end use of the cable.

(j) What sample tests, if any, are required (see Clause 3.20 and Table 7).

(k) Whether type tests are accepted for a cable of the same designated class, type and voltage as a cable which has been type tested, but which has a smaller conductor size than the cable which was previously type tested (see Clause 25.1).

(l) The total length and packing lengths required.

(m) The mass of the cable, if required.

(n) Nominal overall diameter of cable and tolerances.

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APPENDIX B

DETERMINATION OF SHEATH THICKNESS AND PLIABLE ARMOUR STRAND SIZE USING FICTITIOUS CALCULATION METHOD

(Normative)

B1 GENERAL

The basic concept of fictitious calculation of sheath thickness is given in AS/NZS 5000.1. However, because of the specialized nature of the cables specified in this Standard, a somewhat different method is used for this Standard and this is given below.

B2 METHOD

B2.1 Outer sheath

B2.1.1 *General*

The sheath thickness (t_s) specified in Tables 9 to 16 inclusive is calculated by the following equations, subject to a maximum value of t_s of 9.0 mm:

B2.1.2 *For other than Type 210 up to and including 4 mm^2 conductor*

$$t_s = 0.125D_f + 1.3 \text{ mm} \quad \ldots \text{B1}$$

The calculated value (t_s) is then rounded off to one decimal place and is subject to a minimum value of 3.8 mm.

For Type 245 cables

$$\text{Thickness of sheath: } t_s + 0.115D_f + 1.3 \text{ mm} \quad \ldots \text{B2}$$

D_f is the fictitious diameter over the laid-up core assembly and is calculated by the following equations:

(a) Types 209, 240 and 260 (rated 1.1/1.1 kV only):

$$D_f = 1.16\ (d_L + 2t_i + 3.5) + (d_L + 2t_i + 1.0) \quad \ldots \text{B3}$$

(b) Types 209, 240 and 260 (rated 3.3/3.3 kV and higher):

$$D_f = 1.16\ (d_L + 2t_i + 5.5) + (d_L + 2t_i + 3.0) \quad \ldots \text{B4}$$

(c) Type 241 (rated 1.1/1.1 kV only):

$$D_f = 1.16\ (d_L + 2t_i + 2.9) + (d_L + 2t_i + 0.4) \quad \ldots \text{B5}$$

(d) Type 241 (rated 3.3/3.3 kV and higher):

$$D_f = 1.16\ (d_L + 2t_i + 4.5) + (d_L + 2t_i + 2.0) \quad \ldots \text{B6}$$

(e) Type 275:

$$D_f = 1.16\ (d_L + 2t_i + 2.5) + (d_L + 2t_i) \quad \ldots \text{B7}$$

(f) Type 280B:

$$D_f = 1.16\ (d_L + 2t_i + 2.7) + (d_L + 2t_i + 0.2) \quad \ldots \text{B8}$$

(g) For Type 245 (rated at 1.1/1.1 kV):

$$D_f = 1.16\ (d_L + 2t_i + 0.4 + t_f) + (d_L + 2t_i + 0.4) \quad \ldots \text{B9}$$

(h) For Type 245 (rated at 3.3/3.3 kV):

$$D_f = 1.16\ (d_L + 2t_i + 2.0 + t_f) + (d_L + 2t_i + 2.0) \quad \ldots \text{B10}$$

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where

d_L = the fictitious conductor diameter, in millimetres (refer to AS/NZS 5000.1)

t_f = the finger thickness in Table 13

t_i = the thickness of power conductor insulation, in millimetres, specified in Tables 9 to 16.

NOTE: In (a), (b), (c), (d), (f), (g) and (h) above, the constants 1.0, 3.0, 0.4, 2.0, 0.2, 0.4 and 2.0 constitute the fictitious dimensional allowance due to composite screen, conductor/insulation and composite screen, insulation screen, conductor and insulation screens and taped insulation screen respectively, and the constants 3.5, 5.5, 2.9, 4.5 and 2.7 constitute the sum of 2.5 mm (for the cradle finger thickness) plus the appropriate fictitious screen dimension described above. In (e), the constant 2.5 is the cradle finger thickness, in millimetres.

B2.1.3 *For Type 210 up to and including 4 mm^2 conductor*

The sheath thickness is 3.0 mm.

B2.2 Inner sheath and armour (Type 260 only)

The inner sheath thickness and the pliable armour strand size specified in Table 14 is determined from Table B1.

TABLE B1

THICKNESS OF INNER SHEATH AND SIZE OF PLIABLE ARMOUR STRAND

Calculated fictitious diameter (D_f) over the laid-up core assembly	Inner sheath thickness	Pliable armour strand size
mm	mm	No./mm
≤20	2.0	7/0.45
>20 and ≤35	2.5	7/0.71
>35 and ≤50	3.5	7/0.90
>50	4.5	7/1.25

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APPENDIX C

MEASUREMENT OF VOLUME RESISTIVITY

(Normative)

C1 SCOPE

This appendix describes the method of measurement of volume resistivity of semiconductive elastomer cradle separators, covering on earth conductors, extruded insulation screens, and the screen for core assembly, using laboratory prepared samples.

C2 PROCEDURE

The procedure shall be as follows:

(a) Press-cure a sheet (of uniform thickness) of the semiconductive material to achieve a degree of cross-linking not less than that which is achieved in a completed cable.

(b) Prepare samples by cutting from the sheet narrow strips of uniform width and approximately 200 mm long.

(c) Apply four silver-painted electrodes of width not less than 5 mm to one face of the sample, as follows:

(i) Two potential electrodes not less than 50 mm apart.

(ii) One current electrode at least 25 mm beyond each potential electrode.

NOTE: Where a high degree of accuracy is not required, these tests may be carried out with only two electrodes, spaced at least 50 mm apart, for each test.

(d) The measurement is carried out at a temperature of 23 ±3°C using a.c. or d.c. voltage. The power of the test circuit shall not exceed 100 mW.

C3 CALCULATION

Volume resistivity shall be calculated as follows:

$$\rho = \frac{Rwt}{1000\,L} \qquad \ldots \text{C1}$$

where

ρ = volume resistivity, in ohm metres

R = measured resistance, ohms

w = width of sample, in millimetres

t = thickness of sample, in millimetres

L = distance between potential electrodes, in millimetres.

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NOTES

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