

Australian/New Zealand Standard™

Electric cables—Polymeric insulated— For distribution and service applications

Originated as AS 1178—1986 and AS C155—1956.
Previous edition AS/NZS 3155:1995.
AS 1178—1986 and AS/NZS 3155:1995 jointly revised and
redesignated as AS/NZS 4961:2003.

COPYRIGHT

© Standards Australia/Standards New Zealand

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.

Jointly published by Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001
and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 4271 8

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-003, Electric Wires and Cables.

The objective of this Standard is to specify a range of cables for distribution and service applications at working voltages up to and including 0.6/1(1.2) kV. This Standard supplements existing Standard AS/NZS 4026.

Section 2 of this Standard will supersede AS/NZS 3155:1995, *Approval and test specification—Electric cables—Neutral screened—For working voltages up to and including 0.6/1 kV*.

Section 3 of this Standard will supersede AS 1178—1986, *Concentric wire neutral cables—XLPE insulated—For electricity supply at working voltages of 0.6/1 kV*.

Section 4 of this Standard specifies a range of single core PVC or XLPE insulated distribution and service cables used in New Zealand.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	5
1.2 APPLICATION	5
1.3 REFERENCED DOCUMENTS	5
1.4 DEFINITIONS	6
1.5 VOLTAGE DESIGNATION	7
1.6 MAXIMUM CONTINUOUS CONDUCTOR TEMPERATURE	7
SECTION 2 PVC OR XLPE INSULATED NEUTRAL WIRE SCREENED CABLES	
2.1 SCOPE OF SECTION	8
2.2 CONSTRUCTION	8
2.3 CORE CONDUCTORS	8
2.4 INSULATION	8
2.5 CONFIGURATION	9
2.6 FILLERS AND BINDER TAPES	9
2.7 SCREEN	9
2.8 SHEATH	10
2.9 MARKING OF CABLE	10
2.10 PREPARATION FOR DELIVERY	11
2.11 MARKING OF PACKAGING	11

SECTION 5 XLPE INSULATED BUNDLED UNDERGROUND DISTRIBUTION AND SERVICE CABLES

5.1	SCOPE OF SECTION.....	23
5.2	CONSTRUCTION	23
5.3	CONDUCTORS.....	23
5.4	INSULATION.....	23
5.5	COVERING (OPTIONAL – TO PROVIDE INCREASED RESISTANCE AGAINST TERMITE ATTACK)	24
5.6	CORE IDENTIFICATION.....	24
5.7	LAY-UP OF CORES	24
5.8	MARKING OF CABLE	24
5.9	MARKING OF PACKAGING.....	25
5.10	PREPARATION FOR DELIVERY	25
5.11	TESTS.....	25
5.12	CABLE DATA.....	26

SECTION 6 XLPE INSULATED SINGLE-CORE DISTRIBUTION AND SERVICE CABLES

6.1	SCOPE OF SECTION.....	27
6.2	CONSTRUCTION	27
6.3	CONDUCTORS.....	27
6.4	INSULATION.....	27
6.5	MARKING OF CABLES.....	28
6.6	PREPARATION FOR DELIVERY	28
6.7	MARKING OF PACKAGING.....	28
6.8	TESTS.....	28

APPENDICES

A	PURCHASING GUIDELINES	29
B	RECOMMENDED INSTALLATION BENDING RADIUS FOR A CABLE.....	30
C	RECOMMENDATIONS FOR INSTALLATION	31

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electric cables—Polymeric insulated—For distribution and service applications**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the construction of a range of cables for distribution and service applications at working voltages up to and including 0.6/1(1.2) kV.

NOTES:

- 1 Guidelines on information that should be supplied with enquiries or orders are provided in Appendix A.
- 2 Recommended installation bending radius for a cable is given in Appendix B.
- 3 Recommendations for installation are given in Appendix C.

1.2 APPLICATION

For the purpose of this Standard, the cables shall comply with the requirements of the following Sections, as appropriate:

- | | |
|-----------|--|
| Section 2 | PVC or XLPE insulated neutral wire screened cables for use in electrical installations including overhead and underground lines. |
| Section 3 | XLPE insulated waveform concentric wire neutral cables for use in electrical installations. |
| Section 4 | PVC or XLPE insulated single-core distribution and service cables for use in electrical installations. |
| Section 5 | XLPE insulated bundled distribution and service cables for use in underground electrical installations. |
| Section 6 | XLPE insulated single-core distribution and service cables for use in |

1.4 DEFINITIONS

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

1.4.1 Approximate thickness

A thickness which is neither guaranteed nor checked. It is used, for example, for the calculation of other dimensional values.

1.4.2 Core

Active conductor with its insulation but not including any protective covering.

1.4.3 Direction of lay

Direction of slope of a core in a laid-up multicore cable or other helically applied cable component.

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.

1.4.4 Maximum continuous conductor temperature

Maximum temperature at which the conductor of the cable may be operated continuously and is the temperature resulting from the combined effect of the ambient temperature and the current loading on the conductor.

1.4.5 Routine tests

Tests made by the manufacturer on each manufactured length of cable to check that each

1.4.9 Wavelength or length of lay

The axial distance between successive crests of the waveform or turns of the helix formed, as appropriate, e.g. by a core of a multi-core cable, wire of a stranded conductor or screen.

1.5 VOLTAGE DESIGNATION

The rated voltage $U_0/U(U_m)$, recognized for the purposes of the Standard is 0.6/1(1.2)kV.

1.6 MAXIMUM CONTINUOUS CONDUCTOR TEMPERATURE

The maximum permissible continuous conductor temperature of cables shall be as follows:

- (a) For cables insulated with V-75 or V-90 75°C.
- (b) For cables insulated with X-90 or X-90UV 90°C.

SECTION 2 PVC OR XLPE INSULATED NEUTRAL WIRE SCREENED CABLES

2.1 SCOPE OF SECTION

This Section specifies the construction, dimensions and tests for PVC or XLPE insulated neutral wire screened cables intended for use in electrical installations including overhead and underground lines at working voltages up to and including 0.6/1(1.2) kV.

Except where otherwise specified, the cables shall comply with the requirements of AS/NZS 5000.1.

NOTE: The neutral screen of a 5-conductor cable may be used as a separate earth conductor.

2.2 CONSTRUCTION

The cable shall consist of one core, two cores laid parallel or two, three or four cores laid up with fillers (where necessary); V-75, V-90 or X-90 insulated with all the cores surrounded by a helically applied concentric wire outer conductor and sheathed. Pilot cores may be included.

2.3 CORE CONDUCTORS

Core conductors shall be of plain or tinned copper or aluminium and shall comply with the

2.5 CONFIGURATION

2.5.1 2-conductor cable

Single core

2.5.2 3-conductor flat cable

2 cores laid parallel

2.5.3 3-conductor circular cable

2 cores laid up helically with fillers (where necessary)

2.5.4 4-conductor cable

3 cores laid up helically with fillers (where necessary)

2.5.5 5-conductor cable

4 cores laid up helically with fillers (where necessary)

2.6 FILLERS AND BINDER TAPES

Where used, fillers and binder tapes shall be of a suitable non-metallic material compatible with the other materials of the cable with which they are in contact.

2.7 SCREEN

2.7.1 Construction

The screen conductor shall be of plain or tinned annealed copper wires complying with AS/NZS 1125, helically applied and uniformly distributed over the core or cores. Where tinning is provided, wires taken from the finished cable need not pass the continuity test for tin plating in AS/NZS 1125.

2.7.2 Resistance

The d.c. resistance of the screen shall not exceed the maximum allowable resistance of the largest core conductor.

2.7.3 Coverage

Coverage by the screen shall be not less than 80 percent for 2-conductor cable and 60 percent for 3-, 4-, and 5-conductor cables when calculated by the following equation:

$$\text{Percentage coverage} = \frac{W}{m} \times 100 \quad \dots 2.7.3(1)$$

where

W = number of wires \times diameter in millimetres of a single wire

$$m = \frac{L\pi d}{\sqrt{[(\pi d)^2 + L^2]}} \quad \dots 2.7.3(2)$$

where

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

d = pitch diameter of screen, in millimetres (see Clause 2.7.4)

2.7.4 Pitch diameter

For circular and flat cables the pitch diameter of the screen d is expressed as follows:

- (a) For circular cables

$$d = d_{ns} - d_{sw} \quad \dots 2.7.4(1)$$

- (b) For flat cables

$$d = (d_i \times 1.637) + d_{sw} \quad \dots 2.7.4(2)$$

where

d_{ns} = the nominal diameter over the screen, in millimetres

d_i = the nominal diameter over the insulation, in millimetres

d_{sw} = diameter of one screen wire, in millimetres

2.8 SHEATH

2.8.1 Material

The sheath shall be either V-75 or V-90 in accordance with AS/NZS 3808.

- (a) For cables with cores insulated with V-75

Sheath of V-75

- (b) For cables with cores insulated with V-90 or X-90

Sheath of V-90

Unless otherwise specified the sheath shall contain not less than 1 percent carbon black added during compounding or extrusion.

2.8.2 Thickness

The average thickness of the sheath, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Tables 2.2 or 2.3 as appropriate.

Cables for direct burial in New Zealand without further protection shall have a specified sheath thickness (t_s) of not less than 3.2 mm.

The specified thickness (t_s) for cables with pilot cores shall be calculated in accordance with AS/NZS 5000.1.

The minimum thickness at any point shall not fall below the specified thickness (t_s) by more than 10 percent of the specified thickness plus 0.10 mm i.e.

$$\text{minimum thickness} = (0.90t_s - 0.10 \text{ mm})$$

2.9 MARKING OF CABLE

2.9.1 Information to be marked

Cables shall be marked with the following information on the sheath:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Year of manufacture.
- (c) Designation of insulation (see Clause 2.4.1).
- (d) The words 'NS ELECTRIC CABLE' and the voltage rating, e.g. 0.6/1 kV.
- (e) The word 'AERIAL', if applicable.
- (f) The word 'UNDERGROUND' in New Zealand, if the sheath thickness is 3.2 mm.

2.9.2 Means of marking

Marking shall be legible, durable and consist of printing, embossing or indenting on the sheath. The distance between the end of one block of marking and the beginning of the next shall not exceed 550 mm.

Letters and figures shall consist of upright block characters. The maximum height of the characters shall be 13 mm and the minimum height 15 percent of the nominal overall diameter of the cable or 3 mm, whichever is greater.

2.10 PREPARATION FOR DELIVERY

Every drum length of cable shall have both ends of the cable sealed to prevent the ingress of water. Suitable measures shall be taken to protect cable on drums from damage. The end of the cable projecting from the drum barrel shall also be protected.

2.11 MARKING OF PACKAGING

Every packaging unit shall have the following information indicated by means of an attached tag or label or by marking directly on the unit:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Drum traceability number.
- (c) The voltage rating e.g. 0.6/1 kV.
- (d) The number and size of the conductors.
- (e) Designation of insulation (see Clause 2.4.1).
- (f) The catalogue number or type number or name or other marking to distinguish the cable.
- (g) Length of cable.

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 a compliance is capable of being verified.

2.12 TESTS

2.12.1 General

Cables shall comply with the tests in Table 2.1.

A type test includes all tests specified in Table 2.1, including the routine and sample tests. The results of the tests shall be recorded and shall be available in the form of a test report.

(b) For 3-conductor cable

Between the core conductors and also between the core conductors connected together and the screen.

(c) For 4- or 5-conductor cable

Between each core conductor and the other core conductors connected together, and also between all core conductors connected together and the screen.

2.12.4 High voltage a.c. test for 4 h on sheath

The high voltage a.c. test for 4 h on the sheath shall be carried out in accordance with AS/NZS 1660.3, except that the sample length of complete cable shall be immersed in water, with the ends kept well clear of the water and with the test voltage applied between the screen and the water.

2.12.5 Insulation resistance constant of sheath

2.12.5.1 *Insulation resistance constant (k_i) measurement at room temperature*

Insulation resistance at ambient temperature shall be measured in accordance with AS/NZS 1660.3, except that the sample length of complete cable shall be immersed in water, with the ends kept well clear of the water and with the test voltage applied between the screen and the water.

2.12.5.2 *Insulation resistance constant (k_i) measurement at elevated temperature*

Insulation resistance at elevated temperature shall be measured in accordance with AS/NZS 1660.3 with the exception as described in Clause 2.12.5.1.

TABLE 2.1
TESTS ON CABLE—PASS CRITERIA, CATEGORY AND REFERENCE

1	2	3	4	5
Test no.	Test	Pass criteria	Category	Reference for test method
1	All appropriate tests, with the exception of resistance and tinning, on conductors taken from the completed cable	As specified in AS/NZS 1125 for the appropriate conductor		
2	All appropriate tests on insulation taken from or measured on the completed cable	As specified in AS/NZS 3808 for the appropriate insulation		
3	All appropriate tests on sheath taken from or measured on the completed cable	As specified in AS/NZS 3808 for the appropriate material		
4	Core conductor resistance	Compliance with the requirements of AS/NZS 1125	Routine	AS/NZS 1660.3
5	Screen resistance	Compliance with Clause 2.7.2	Routine	AS/NZS 1660.3
6	Measurement of insulation thickness	Compliance with the requirements of Clause 2.4.2	Sample	AS/NZS 1660.2.1
7	Measurement of sheath thickness	Compliance with the requirements of Clause 2.8.2	Sample	AS/NZS 1660.2.1
8	High voltage a.c. test for 4 h	No breakdown	Type	AS/NZS 1660.3
9	High voltage a.c. test for 4 h on sheath	No breakdown	Type	Clause 2.12.4
10	Insulation resistance constant of sheath	As specified in AS/NZS 3808	Type	Clause 2.12.5
11	High voltage test for 5 min on insulation	No breakdown	Routine	Clause 2.12.3
12	Spark test:			
	(a) On cores	No breakdown	Routine	AS/NZS 1660.3
	(b) On sheath	No breakdown	Routine	Clause 2.12.2

TABLE 2.2
INSULATION AND SHEATH THICKNESS
(V-75 and V-90 insulated cables)

1	2	3	4	5	6
Nominal cross-sectional area of conductor mm ²	Insulation thickness (<i>t_i</i>) mm	Sheath thickness (<i>t_s</i>)			
		2-conductor cable mm	3-conductor cable mm	4-conductor cable mm	5-conductor cable mm
2.5	0.8	1.8	1.8	1.8	1.8
4	1.0	1.8	1.8	1.8	1.8
6	1.0	1.8	1.8	1.8	1.8
10	1.0	1.8	1.8	1.8	1.8
16	1.0	1.8	1.8	1.8	1.8
25	1.2	1.8	1.8	1.8	1.8
35	1.2	1.8	1.8	1.8	1.8
50	1.4	1.8	1.8	1.9	2.0
70	1.4	1.8	1.9	2.0	2.1
95	1.6	1.8	2.1	2.2	2.3
120	1.6	1.8	2.2	2.3	2.4
150	1.8	1.8	2.3	2.4	2.6
185	2.0	1.8	2.5	2.6	2.8
240	2.2	1.9	2.7	2.9	3.1
300	2.4	2.1	2.9	3.1	3.3

TABLE 2.3
INSULATION AND SHEATH THICKNESS
(X-90 insulated cables)

1	2	3	4	5	6
Nominal cross-sectional area of conductor mm ²	Insulation thickness (<i>t_i</i>) mm	Sheath thickness (<i>t_s</i>)			
		2-conductor cable mm	3-conductor cable mm	4-conductor cable mm	5-conductor cable mm
2.5	0.7	1.8	1.8	1.8	1.8
4	0.7	1.8	1.8	1.8	1.8
6	0.7	1.8	1.8	1.8	1.8
10	0.7	1.8	1.8	1.8	1.8
16	0.7	1.8	1.8	1.8	1.8
25	0.9	1.8	1.8	1.8	1.8
35	0.9	1.8	1.8	1.8	1.8
50	1.0	1.8	1.8	1.8	1.9
70	1.1	1.8	1.9	2.0	2.1
95	1.1	1.8	2.0	2.1	2.2
120	1.2	1.8	2.1	2.2	2.4
150	1.4	1.8	2.3	2.4	2.5
185	1.6	1.8	2.4	2.6	2.7
240	1.7	1.9	2.7	2.8	3.0
300	1.8	2.0	2.9	3.0	3.2

SECTION 3 XLPE INSULATED WAVEFORM CONCENTRIC WIRE NEUTRAL CABLES

3.1 SCOPE OF SECTION

This Section specifies the construction, dimensions and tests for XLPE insulated waveform concentric wire neutral cables having aluminium core conductors intended for use in electrical installations at working voltages up to and including 0.6/1(1.2) kV.

Except where otherwise specified, the cables shall comply with the requirements of AS/NZS 5000.1.

3.2 CONSTRUCTION

The cable shall consist of 3 cores laid up helically with a waveform concentric wire neutral and sheathed.

3.3 CORE CONDUCTORS

Core conductors shall be of solid sector shaped aluminium in accordance with AS/NZS 1125. Conductors shall be selected from the rationalized range of sizes, namely 120 mm², 185 mm² or 240 mm².

3.4 INSULATION

3.4.1 Material

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

3.4.2 Thickness

The average thickness of insulation, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Table 3.2 and the minimum thickness at any given point shall not fall below the specified thickness (t_i) by more than 10 percent of the specified thickness plus 0.10 mm, i.e.

$$\text{minimum thickness} = (0.90t_i - 0.10 \text{ mm})$$

3.4.3 Core identification

Cores shall be coloured red, white (or uncoloured) and blue.

3.5 LAY UP OF CORES

Cores shall be laid-up with a right-hand direction of lay.

3.6 BINDER TAPE

A non-metallic binder tape shall be applied over the laid-up cores with a gap and shall be compatible with other materials of the cable with which it is in contact.

3.7 BEDDING

The bedding shall consist of a layer of soft non-vulcanizable elastomeric material. The material shall be compatible with the core insulation and sheath and be readily removable.

3.8 WAVEFORM CONCENTRIC WIRE NEUTRAL CONDUCTOR

3.8.1 Material

The wire of the neutral conductor shall be of plain annealed copper in accordance with AS/NZS 1125.

3.8.2 Formation

The minimum diameter of wires in the neutral conductor shall conform to the requirements of Table 3.2. The wires shall be uniformly distributed and applied with a waveform lay. The design gap between the adjacent wires shall not exceed 4 mm.

The wavelength of the waveform lay and the minimum developed length of each wire in a wavelength shall be as follows:

(a) Wavelength

The wavelength shall be within ± 5 percent of the value given in Table 3.2.

(b) Minimum developed length

The minimum developed length of each wire in a wavelength shall be 106 percent of the wavelength.

3.8.3 Resistance

The d.c. resistance of the neutral conductor shall not exceed the value given in Table 3.2.

3.9 SHEATH

3.9.1 Material

The sheath shall be V-90 in accordance with AS/NZS 3808.

3.9.2 Thickness

The average thickness of the sheath, when determined in accordance with AS/NZS 1660.2.1, shall be not less than that specified in Table 3.2 and the minimum thickness at any point shall not fall below the specified thickness (t_s) by more than 10 percent of the specified thickness plus 0.15 mm, i.e.

$$\text{minimum thickness} = (0.90t_s - 0.15 \text{ mm})$$

3.9.3 Colour

The sheath shall be coloured black.

3.10 MARKING OF CABLE

3.10.1 Information to be marked

Cables shall be marked with the following information on the sheath—

- (a) a registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified;
- (b) year of manufacture;
- (c) designation of insulation, i.e. X-90;
- (d) the words 'CWN ELECTRIC CABLE' and the voltage rating, e.g. 0.6/1 kV.

3.10.2 Means of marking

Marking shall be legible, durable and comprise block characters arranged along two approximately diametrically opposed lines.

Letters and figures shall consist of upright block characters. The maximum height of the characters shall be 13 mm and the minimum height 15 percent of the nominal overall diameter of the cable or 3 mm, whichever is greater.

The gap between the end of the block of marking and the beginning of the next shall not exceed 550 mm.

3.11 PREPARATION FOR DELIVERY

Every drum length of cable shall have both ends of the cable sealed to prevent the ingress of water. Suitable measures shall be taken to protect cable on drums from damage. The end of the cable projecting from the drum barrel shall also be protected.

3.12 MARKING OF PACKAGING

Every packaging unit of cable shall have the following information indicated by means of an attached tag or label or by marking directly on the unit:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Drum traceability number.
- (c) The voltage rating, e.g. 0.6/1 kV.
- (d) The core conductor size.
- (e) The catalogue number or type number or name or other marking to distinguish the cable.
- (f) Length of cable.

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.

3.13 TESTS

3.13.1 General

Cables shall comply with the tests in Table 3.1.

A type test includes all tests specified in Table 3.1, including the routine and sample tests.

The results of the tests shall be recorded and shall be available in the form of a test report.

3.13.2 Spark test on sheath

The spark test on the sheath shall be carried out between the external surface of the sheath and the neutral conductor. The test method shall be in accordance with AS/NZS 1660.3, except that the test voltage shall be that applicable to an insulation of the same thickness as the sheath.

The neutral conductor shall be earthed during the test.

3.13.3 High voltage test for 5 min on insulation

The completed cable shall be subjected to the high voltage test for 5 min in accordance with AS/NZS 1660.3 with the test voltage applied as follows:

Between each core conductor and the other core conductors connected together, and also between all core conductors connected together and the neutral conductor.

3.13.4 High voltage a.c. test for 4 h on sheath

The high voltage a.c. test for 4 h on the sheath shall be carried out in accordance with AS/NZS 1660.3, except that the sample length of complete cable shall be immersed in water, with the ends kept well clear of the water and with the test voltage applied between the neutral conductor and the water.

3.13.5 Insulation resistance constant of sheath

3.13.5.1 Insulation resistance constant (k_i) measurement at room temperature

Insulation resistance at ambient temperature shall be measured in accordance with AS/NZS 1660.3, except that the sample length of complete cable shall be immersed in water, with the ends kept well clear of the water and with the test voltage applied between the neutral conductor and the water.

3.13.5.2 Insulation resistance constant (k_i) measurement at elevated temperature

Insulation resistance at elevated temperature shall be measured in accordance with AS/NZS 1660.3 with the exception as described in Clause 3.13.5.1.

TABLE 3.1
TESTS ON CABLE—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		
2	All appropriate tests on core insulation taken from or measured on the completed cable	As specified in AS/NZS 3808		
3	All appropriate tests on sheath taken from or measured on the completed cable	As specified in AS/NZS 3808		
4	Core conductor resistance	As specified in AS/NZS 1125	Routine	AS/NZS 1660.3
5	Neutral conductor resistance	Compliance with Table 3.2	Routine	AS/NZS 1660.3
6	Measurement of insulation thickness	Compliance with Clause 3.4.2	Sample	AS/NZS 1660.2.1
7	Measurement of sheath thickness	Compliance with Clause 3.9.2	Sample	AS/NZS 1660.2.1
8	High voltage a.c. test for 4 h	No breakdown	Type	AS/NZS 1660.3
9	High voltage a.c. test for 4 h on sheath	No breakdown	Type	Clause 3.13.4
10	Insulation resistance constant of sheath	Compliance with AS/NZS 3808	Type	Clause 3.13.5
11	High voltage test for 5 min on insulation	No breakdown	Routine	Clause 3.13.3
12	Spark test:			
	(a) On cores	No breakdown	Routine	AS/NZS 1660.3
	(b) On sheath	No breakdown	Routine	Clause 3.13.2

TABLE 3.2
CABLE DETAILS

Ref. no	Item	Unit	Nominal cross-sectional area of core conductor mm ²		
			120	185	240
1	Insulation thickness (t_i)	mm	1.2	1.6	1.7
2	Neutral conductors				
	Minimum diameter of wires	mm	1.30	1.50	1.60
	Nominal wavelength of wires	mm	270	300	375
3	Approximate bedding thickness	mm	1.0	1.0	1.0
4	Sheath thickness (t_s)	mm	2.2	2.5	2.8
5	Approximate overall diameter of completed cable*	mm	37.8	46.1	51.5
6	Maximum d.c. resistance at 20°C: Neutral conductor	Ω/km	0.298	0.205	0.164

* The approximate overall diameter is based on the use of the minimum permissible wire size specified

SECTION 4 PVC OR XLPE INSULATED SINGLE-CORE DISTRIBUTION AND SERVICE CABLES

4.1 SCOPE OF SECTION

This Section specifies the construction, dimensions and tests for a selected range of single-core aluminium low voltage distribution and service cables intended for use in electrical installations at working voltages up to and including 0.6/1(1.2) kV.

Except where otherwise specified, the cables shall comply with the requirements of AS/NZS 5000.1.

4.2 CONSTRUCTION

The cable shall be single-core, V-75 or X-90 insulated, sheathed or unsheathed.

4.3 CONDUCTORS

The conductors shall be stranded compacted or solid circular aluminium in accordance with AS/NZS 1125. The conductor shall be selected from the rationalized range of sizes, namely 25 mm², 50 mm², 70 mm², 95 mm², 120 mm² and 185 mm².

4.4 INSULATION

4.4.1 Material

The insulation shall be V-75 or X-90 in accordance with AS/NZS 3808.

4.4.2 Thickness

The average thickness of insulation determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Table 4.1 and the minimum thickness at any point shall not fall below the specified thickness (t_i) by more than 10 percent of the specified thickness plus 0.1 mm, i.e.

$$\text{minimum thickness} = (0.90t_i - 0.10 \text{ mm})$$

TABLE 4.1
INSULATION THICKNESS

Nominal cross-sectional area of conductor	Insulation thickness (t_i)			
	mm			
	V-75 with sheath	X-90 with sheath	V-75 without sheath	X-90 without sheath
mm ²				
25	1.2	0.9	2.5	1.7
50	1.4	1.0	2.5	1.8
70	1.4	1.1	2.8	1.9
95	1.6	1.1	2.8	1.9
120	1.6	1.2	2.8	2.0
185	2.0	1.6	2.8	2.4

4.5 SHEATH (OPTIONAL)

4.5.1 Material

The sheath shall be either 4V-75 or 5V-90 in accordance with AS/NZS 3808.

- (a) For cables with cores insulated with V-75

Sheath of 4V-75

- (b) For cables with cores insulated with X-90

Sheath of 5V-90

4.5.2 Thickness

The average thickness of sheath, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Table 4.2 and the minimum thickness at any point shall not fall below the specified thickness (t_s) by more than 15 percent of the specified thickness plus 0.1 mm. i.e.

$$\text{minimum thickness} = (0.85t_s - 0.10 \text{ mm})$$

TABLE 4.2
SHEATH THICKNESS

Nominal cross-sectional area of conductor mm ²	Sheath thickness (t_s) mm	
	V-75 insulation	X-90 insulation
25	1.4	1.4
50	1.4	1.4
70	1.4	1.4
95	1.5	1.5
120	1.5	1.5
185	1.7	1.6

4.6 MARKING OF CABLES

The cable shall have marking in accordance with AS/NZS 5000.1 and be metre marked.

4.7 PREPARATION FOR DELIVERY

Every drum length of cable shall have both ends of the cable sealed to prevent the ingress of water. Suitable measures shall be taken to protect cable on drums from damage. The end of the cable projecting from the drum barrel shall also be protected.

4.8 MARKING OF PACKAGING

Every packaging unit shall have the following information indicated by means of an attached tag or label or by marking directly on the unit:

- A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- Drum traceability number.
- The voltage rating e.g. 0.6/1 kV.
- The number and size of the conductors.
- Designation of insulation (see Clause 4.4.1).

- (f) The catalogue number or type number or name or other marking to distinguish the cable.
- (g) Length of cable.

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 a compliance is capable of being verified.

4.9 TESTS

Cables shall be tested in accordance with the requirements specified in AS/NZS 5000.1.

SECTION 5 XLPE INSULATED BUNDLED UNDERGROUND DISTRIBUTION AND SERVICE CABLES

5.1 SCOPE OF SECTION

This Section specifies the construction, dimensions and tests for a selected range of low voltage bundled distribution and service cables intended for use in electrical installations at working voltages up to and including 0.6/1(1.2) kV.

Except where otherwise specified, the cables shall comply with the requirements of AS/NZS 5000.1. In addition, the insulated conductors shall be tested to the requirements of reinforced insulation, as defined in AS/NZS 3100, which allows the cable to be buried directly without further protection in Australia.

5.2 CONSTRUCTION

The cable shall consist of four, X-90 or X-90UV insulated cores, covered with HDPE or non-covered, and laid-up. Refer to cable cross-section illustrated in Figure 1.

5.3 CONDUCTORS

Conductors shall be stranded aluminium in accordance with AS/NZS 1125 and as specified in Table 5.1.

Each of the four cores in a cable shall have the same nominal conductor size.

The conductor shall be selected from the rationalized range of sizes, namely 35 mm² and 150 mm².

TABLE 5.1
CONDUCTOR DETAILS

Nominal cross-sectional area of conductor mm ²	Form of conductor	Number of strands
35	Circular stranded	19
150	Circular compacted	Refer to AS/NZS 1125

5.4 INSULATION

5.4.1 Material

The insulation shall be either X-90UV or uncoloured X-90, in accordance with AS/NZS 3808. Uncoloured X-90 shall only be used for cables with a covering.

5.4.2 Thickness

The average thickness of insulation, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Table 5.2 and the minimum thickness at any point shall not fall below the specified thickness (t_i) by more than 10 percent of the specified thickness plus 0.1 mm, i.e.

$$\text{minimum thickness} = (0.90t_i - 0.10 \text{ mm})$$

TABLE 5.2
INSULATION AND COVERING THICKNESS

Nominal cross-sectional area of conductor	Insulation thickness for cable with covering (t_i)	Insulation thickness for cable without covering (t_i)	Minimum thickness at any point of covering
mm ²	mm	mm	mm
35	0.9	1.7	1.1
150	1.4	2.2	1.4

5.5 COVERING (OPTIONAL – TO PROVIDE INCREASED RESISTANCE AGAINST TERMITE ATTACK)

5.5.1 Material

The covering shall consist of black HDPE in accordance with AS/NZS 3808.

5.5.2 Thickness

The minimum thickness at any point shall be as specified in Table 5.2.

5.6 CORE IDENTIFICATION

The cores shall be printed with words in accordance with AS/NZS 5000.1. The words shall be RED, WHITE, BLUE and NEUTRAL to indicate active and neutral cores.

5.7 LAY-UP OF CORES

The four cores shall be laid up in a helical configuration with right hand lay in the sequence: red, white, blue and neutral. The lay length shall be between 22 and 28 times the diameter of the circumscribing circle over the laid-up cores.

5.8 MARKING OF CABLE

5.8.1 Information to be marked

A core shall be legibly and durably marked with the following information on the outermost surface:

- A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- Year of manufacture.
- Designation of insulation and, if applicable, covering (see Clauses 5.4 and 5.5).
- The words 'UNDERGROUND ELECTRIC CABLE' and the voltage rating i.e. 0.6/1 kV.
- Nominal conductor cross-sectional area.
- Metre marking on one of the active cores, with no allowance for lay, commencing with the lowest number at the inner end of the drum.
- Core identification (refer Clause 5.6).

5.8.2 Means of marking

Means of marking are as follows:

(a) Marking on outer surface

The marking shall consist of printing in a contrasting colour. The distance between the end of one block of marking and the beginning of the next shall not exceed 550 mm except for metre marking and core identification which shall not exceed 150 mm for active cores and 50 mm for the neutral core.

(b) Alternative means of marking

Marking other than core identification and metre marking, which shall comply with Clause 5.8.2(a), shall consist of printing on the outer surface of the insulation or on a tape which is included in one active core throughout the length of the cable. The distance between the end of one block of marking and the beginning of the next shall not exceed 275 mm.

5.9 MARKING OF PACKAGING

Every drum shall have the following information indicated by means of an attached tag or label or by marking directly on the unit:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Drum traceability number.
- (c) The voltage rating i.e. 0.6/1 kV.
- (d) The number of cores (4) and size of the conductor(s) and the conductor material.
- (e) Designation of insulation and, if applicable, covering (see Clauses 5.4 and 5.5).
- (f) A catalogue or type number, name or other marking to distinguish the cable.
- (g) Length of cable.
- (h) An arrow and the words 'ROLL THIS WAY' indicating the direction to roll the drum.

5.10 PREPARATION FOR DELIVERY

Each core on every drum length of cable shall have both ends of the cable sealed to prevent the ingress of water. Suitable measures shall be taken to protect cable on drums from damage. The end of the cable projecting from the drum barrel shall also be protected.

5.11 TESTS

Cables shall be tested in accordance with the requirements specified in AS/NZS 5000.1. For the purpose of these tests, the covering, if used, shall be considered a non-metallic sheath.

An additional Type Test shall be performed by immersion in water of at least 3 m of cable. A voltage of 3750 V a.c. (nominally 50 Hz) shall be applied between the conductors and the water and maintained for at least 1 min. The cable shall be deemed to have passed the test if no breakdown of the insulation has occurred.

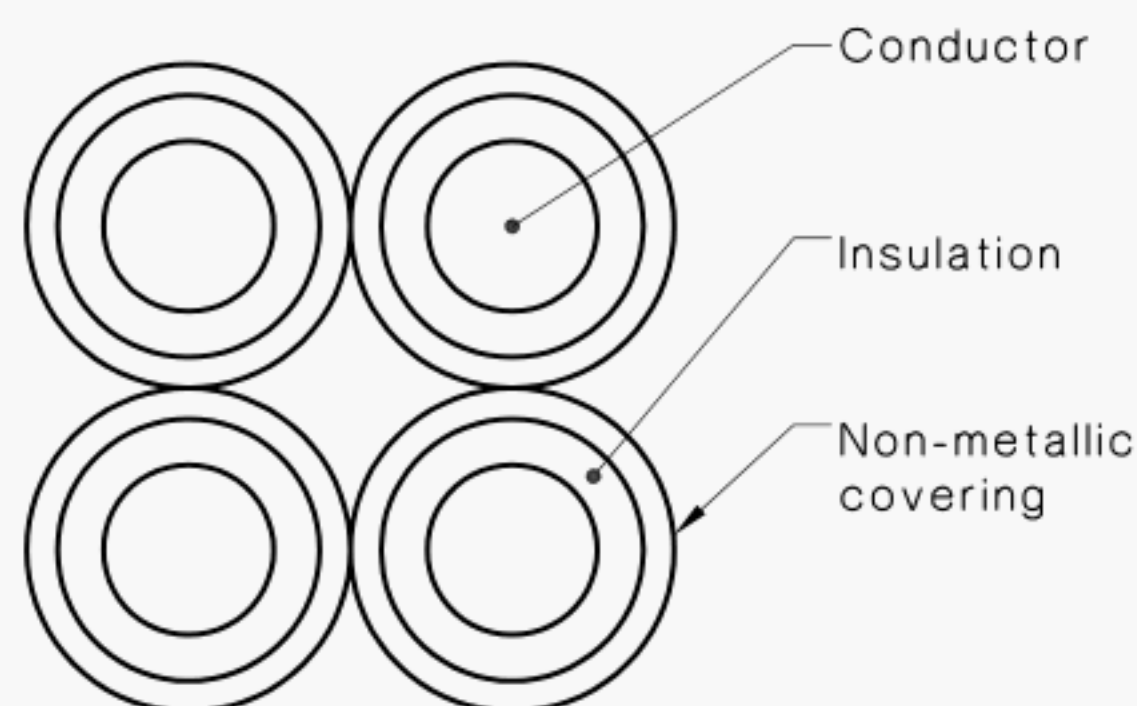


FIGURE 1 XLPE INSULATED 0.6/1(1.2) kV BUNDLED DISTRIBUTION AND SERVICE CABLES (INCLUDING COVERING)

5.12 CABLE DATA

Cable data and recommendations to assist in the selection of appropriate cables are provided in Table 5.3.

TABLE 5.3

XLPE INSULATED BUNDLED DISTRIBUTION AND SERVICE CABLES

Characteristic	Unit	Calculated or recommended value, as appropriate	
Nominal area of core conductors	mm ²	35	150
Approximate diameter of cable	mm	26.5	45.2
Approximate cable mass	kg/m	0.6	2.0
Recommended maximum pulling tension (on all four cores as a bundle)	kN	7.0	30
Recommended minimum bending radius:			
(i) during installation	mm	240	630
(ii) setting	mm	160	410
Minimum diameter of drum barrel	Times cable diameter	10	10
Maximum continuous conductor temperature	°C	90	90
Maximum continuous current rating*:			
(i) direct buried	A	135	290
(ii) in PVC duct (65 mm internal diameter)	A	100	235
Maximum a.c. resistance at 50 Hz and 90°C	Ω/km	1.11	0.265
Positive and negative sequence impedance at 50 Hz and 90°C	Ω/km	1.11 + j0.0947	0.265 + j0.0876
Zero sequence impedance at 20°C	Ω/km	3.47 + j0.0947	0.825 + j0.0876
Voltage drop—3-phase	mV/A.m	1.93	0.483
Three-phase symmetrical fault rating for 1 second	kA	3.31	14.2

* Based on a soil resistivity of 1.2°C m/W, soil temperature of 25°C and burial at 1 m depth.

SECTION 6 XLPE INSULATED SINGLE-CORE DISTRIBUTION AND SERVICE CABLES

6.1 SCOPE OF SECTION

This Section specifies the construction, dimensions and tests for a range of single-core low voltage distribution and service cables intended for use in electrical installations at working voltages up to and including 0.6/1(1.2) kV.

Except where otherwise specified, the cables shall comply with the requirements of AS/NZS 5000.1.

6.2 CONSTRUCTION

The cable shall be single-core, X-90 insulated.

6.3 CONDUCTORS

The conductors shall be stranded or stranded compacted plain annealed copper or aluminium in accordance with AS/NZS 1125.

6.4 INSULATION

6.4.1 Material

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

6.4.2 Thickness

The average thickness of insulation determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness specified in Table 6.1 and the minimum thickness at any point shall not fall below the specified thickness (t_i) by more than 10 percent of the specified thickness plus 0.1 mm, i.e.

$$\text{minimum thickness} = (0.90t_i - 0.10 \text{ mm})$$

TABLE 6.1
INSULATION THICKNESS

Nominal cross-sectional area of conductor	Insulation thickness (t_i)
mm ²	mm
16	1.5
25	1.7
35	1.7
50	1.8
70	1.9
95	1.9
120	2.0
150	2.2
185	2.4
240	2.5
300	2.6
400	2.8

6.5 MARKING OF CABLES

The cable shall have marking in accordance with AS/NZS 5000.1 and be metre marked.

6.6 PREPARATION FOR DELIVERY

Every drum length of cable shall have both ends of the cable sealed to prevent the ingress of water. Suitable measures shall be taken to protect cable on drums from damage. The end of the cable projecting from the drum barrel shall also be protected.

6.7 MARKING OF PACKAGING

Every packaging unit shall have the following information indicated by means of an attached tag or label or by marking directly on the unit:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Drum traceability number.
- (c) The voltage rating e.g. 0.6/1 kV.
- (d) The number and size of the conductors.
- (e) Designation of insulation (see Clause 6.4.1.).
- (f) The catalogue number or type number or name or other marking to distinguish the cable.
- (g) Length of cable.

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 a compliance is capable of being verified.

6.8 TESTS

Cables shall be tested in accordance with the requirements specified in AS/NZS 5000.1

APPENDIX A
PURCHASING GUIDELINES
(Informative)

A1 SCOPE

This Appendix lists those items which should either be specified by the purchaser with the enquiry or order for cables to this Standard or be subject to agreement between the purchaser and the manufacturer.

A2 ITEMS TO BE SPECIFIED BY THE PURCHASER

- (a) The number of this Standard and relevant Section.
- (b) Core conductor size, i.e. nominal cross-sectional area.
- (c) Type of conductor (see Clauses 2.3 and 4.3).
- (d) Number of cores (see Section 2).
- (e) Configuration (see Section 2).
- (f) Type of insulation (see Sections 2 and 4), e.g. V-75.
- (g) Whether covering required over insulated core (see Section 5).
- (h) Length of cable and individual drum lengths.

A3 ITEMS SUBJECT TO AGREEMENT BETWEEN PURCHASER AND MANUFACTURER

- (a) Type and size of drum to be used for delivery of the cable.
- (b) Requirements for lagging of cable drums.
- (c) Method for sealing ends of cable against ingress of water during storage, delivery and while awaiting installation.
- (d) Whether a type test report is required.
- (e) The number and frequency of sample tests.
- (f) Arrangements for the witnessing of tests.

APPENDIX B

RECOMMENDED INSTALLATION BENDING RADIUS FOR A CABLE

(Informative)

B1 INSTALLATION BENDING RADIUS

The recommended minimum installation bending radius for a cable is determined by reference to the overall diameter of the cable multiplied by the appropriate factor given in Table B1.

TABLE B1
RECOMMENDED MINIMUM INSTALLATION BENDING RADIUS
(in multiples of cable overall diameter)

Applicable Section of this Standard	Cable description	Bending radii as a factor of cable diameter	
		During installation	Installed
2	PVC or XLPE insulated neutral wire screened cables	18	12
3	XLPE insulated waveform concentric wire neutral cables	18	12
4	PVC or XLPE insulated single-core distribution and service cables:	12	8
	With solid conductor	12	8
	With stranded conductor and overall diameter ≤ 25 mm	6	4
	With stranded conductor and overall diameter > 25 mm	9	6
5	XLPE insulated bundled underground distribution and service cables:		
	Complete cable, ≤ 50 mm ² conductor size	9	6
	Complete cable, > 50 mm ² conductor size	14	9
	Individual cores	6	4
6	XLPE insulated single-core distribution and service cables:		
	With overall diameter ≤ 25 mm	6	4
	With overall diameter > 25 mm	9	6

APPENDIX C
RECOMMENDATIONS FOR INSTALLATION
(Informative)

C1 MINIMUM TEMPERATURE DURING INSTALLATION

It is desirable that the cables specified in this Standard should be installed only when both cable and ambient temperatures are above a temperature of 0°C and the cable has remained so for the previous 24 h, or when special precautions have been taken to maintain the cable above this temperature to avoid risk of damage during handling.

C2 AFTER INSTALLATION TEST

Should a test after installation be required, the following procedure is recommended.

After installation of cable complying with Section 2 or 3, the integrity of the sheath should be checked by an insulation resistance test at 2.5 kV d.c between the neutral conductor and earth. The insulation resistance measured after one minute's electrification shall be at least 1 MΩ/km.

After installation of cable complying with Section 4, 5 or 6, the integrity of the insulation (and covering where applied) should be checked by an insulation resistance test at 2.5 kV d.c between each conductor and earth. The insulation resistance measured after one minute's electrification shall be at least 1 MΩ/km.

NOTES