

Australian/New Zealand Standard™

**Electric cables—Impregnated paper
insulated—For working voltages up to
and including 19/33 (36) kV**



AS/NZS 1026:2004

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-003, Electric Wires and Cables. It was approved on behalf of the Council of Standards Australia on 13 February 2004 and on behalf of the Council of Standards New Zealand on 5 March 2004. It was published on 29 April 2004.

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This Standard was issued in draft form for comment as DR 02316.

Australian/New Zealand Standard™

Electric cables—Impregnated paper insulated—For working voltages up to and including 19/33 (36) kV

Originated as AS C92—1941.
Previous edition AS 1026—1992.
Jointly revised and designated as AS/NZS 1026:2004.

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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 5884 3

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee, EL-003 Electric Wires and Cables to supersede AS 1026—1992 and NZS/AS 1026—1992, *Electric cables—Impregnated paper insulated—Working voltages up to and including 33 kV*.

The objective of this Standard is to specify the construction, dimensions and tests for paper insulated and lead alloy sheathed cables for working voltages up to and including 19/33 (36) kV.

In the preparation of this Standard, consideration was given to IEC 60055-1, *Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables)* Part 1: *Tests on cables and their accessories*, IEC 60055-2, *Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables)* Part 2: *General and construction requirements*, and BS 6480, *Impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltage up to and including 33 000 V*. The Standards Australia/Standards New Zealand Committee concurs with the comment in the Foreword of BS 6480 that, because of different local and regional requirements, it has not been possible to adopt the IEC Publication as a national Standard. Consequently, the construction and voltage ratings of cables in the Australian/New Zealand Standard have not been changed from the previous edition and are identical with corresponding cables in BS 6480.

Acknowledgment is made of the content extracted from BS 6480 and IEC 60055.

This Standard differs from the 1992 edition in the following significant ways:

- (a) The Standard is published as a Joint Australian/New Zealand Standard.
- (b) 0.6/1 (1.2) kV single-core, two-core and three-core cable constructions and all 1.9/3.3 (3.6) kV cable constructions have been deleted.
- (c) Bedding and armour have been designated as optional processes.
- (d) PE and LLDPE have been included as additional extruded bedding and non-metallic sheathing materials.
- (e) Extruded bedding and non-metallic sheathing materials have been referenced to AS/NZS 3808.
- (f) An internal cable pressure test has been included.

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

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electric cables—Impregnated paper insulated—For working voltages up to and including 19/33 (36) kV****1 SCOPE**

This Standard specifies requirements for non-draining mass-impregnated paper insulated and lead alloy sheathed cables for working voltage up to and including 19/33 (36) kV. Provision is made for extruded or lapped non-metallic protective coverings over the lead alloy sheath, with or without galvanized steel wire armour. Some typical constructions are shown in Figure 1.

NOTES:

- 1 Recommendations for selection and operation are given in Appendix A and those for installation are given in Appendix B.
- 2 Purchasing guidelines are provided in Appendix C.

The following cables are included in this Standard:

- (a) 0.6/1 (1.2) kV four-core.
- (b) 3.8/6.6 (7.2) kV single-core and three-core belted construction.
- (c) 6.35/11 (12) and 11/11 (12) kV single-core and three-core belted or screened construction.
- (d) 12.7/22 (24) kV and 19/33 (36) kV single-core and three-core screened or three-core separately leaded (SL).

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|--------|---|
| 1931 | High voltage testing techniques |
| 1931.1 | Part 1: General definitions and test requirements |
| 1931.2 | Part 2: Measuring systems |
| 3983 | Metal drums for insulated electric cables and bare conductors |

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 |
| 1660.3 | Method 3: Electrical tests |
| 2857 | Timber drums for insulated electric cables and bare conductors |
| 2893 | Electric cables—Lead and lead alloy sheaths—Composition |
| 3008 | Electric installations—Selection of cables |
| 3008.1 | Part 1: Cables for alternating voltages up to and including 0.6/1 kV |
| 3808 | Insulating and sheathing materials for electric cables |

3863	Galvanized mild steel wire for armouring cables
BS	
6480	Impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltages up to and including 33 000 V
ASTM	
D938	Standard test method for congealing point of petroleum waxes, including petrolatum
IEC	
60554	Specification for cellulosic papers for electrical purposes
60554-2	Part 2: Methods of test
ERA	
69.30	Current rating standards for distribution cables
69.30.1	Part 1: Sustained current ratings for paper-insulated lead-sheathed cables to BS 6480 Part 1: 1969 (ac 50Hz and dc)
F/T195	Report. A basis for short-circuit ratings for paper insulated lead-sheathed cables up to 11 kV

3 DEFINITIONS

For the purpose of this Standard the definitions in the referenced documents and those below apply.

3.1 Approximate value

A value which is neither guaranteed nor checked.

3.2 Belted cable

A multicore cable in which part of the insulation is applied to each conductor and the remainder is applied as a belt over the assembled core.

3.3 Breaking joint

Where tapes are applied helically with a gap between turns and the gaps in successive tapes do not coincide.

3.4 Conductor screen

A layer of semiconductive material applied directly over the conductor to ensure a uniform voltage stress in the surrounding insulation.

3.5 Core (of a cable)

An assembly comprising a conductor, conductor screen (if any), insulation and insulation screen (if any).

3.6 Direction of lay

The slope of paper tape, core or armour wire when the 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.

3.7 Maximum continuous conductor temperature

The 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 of the conductor.

3.8 Multicore cable

A cable comprising two or more screened or unscreened cores.

3.9 Nominal values

Value by which a quantity is designated and which is often used in tables.

3.10 Non-hygroscopic

The property of a material whereby after being preconditioned in an oven at $50 \pm 5^\circ\text{C}$ for 24 ± 1 h and allowed to cool in a desiccator, it does not absorb more than 5 percent by weight of moisture during a 48 h treatment in humidity of 95 ± 4 percent at a temperature of $20 \pm 5^\circ\text{C}$.

3.11 Registration

The ratio by which the breaking joint in successive layers are staggered, i.e. a 80/20 registration has 80 percent of the tape width lying in front of and 20 percent behind the trailing edge of the layer beneath it.

3.12 Screened cable

A cable in which the insulation of each conductor is separately enclosed in a conducting layer to ensure a radial electric field surrounding the conductor.

3.13 Separately leaded (SL) cable

A three-core cable in which each core is individually screened and sheathed with lead alloy.

3.14 Voltage designation

The indication of the rated voltages U_o , U and U_m expressed in the form $U_o/U (U_m)$ or, in the case for d.c. systems, U_o

where

- U_o is the r.m.s. power frequency voltage to earth of the supply system or d.c. voltage of the supply system for which the cable is designed
- U is the r.m.s. power frequency voltage between phases of the supply system and for which the cable is designed
- U_m is the maximum r.m.s. power-frequency voltage between any two conductors for which cables and accessories are designed. It is the highest voltage that can be sustained under normal operating conditions at any time and at any point in a system. It excludes temporary voltage variations due to fault conditions and sudden disconnection of large loads.

4 OPERATING VOLTAGES

The rated voltages, $U_o/U (U_m)$ recognized for the purposes of this Standard are—

0.6/1 (1.2) kV, 3.8/6.6 (7.2) kV, 6.35/11 (12) kV, 11/11 (12) kV, 12.7/22 (24) kV and 19/33 (36) kV.

5 MAXIMUM CONDUCTOR TEMPERATURES

The maximum continuous conductor temperatures of cables are specified in Table 1.

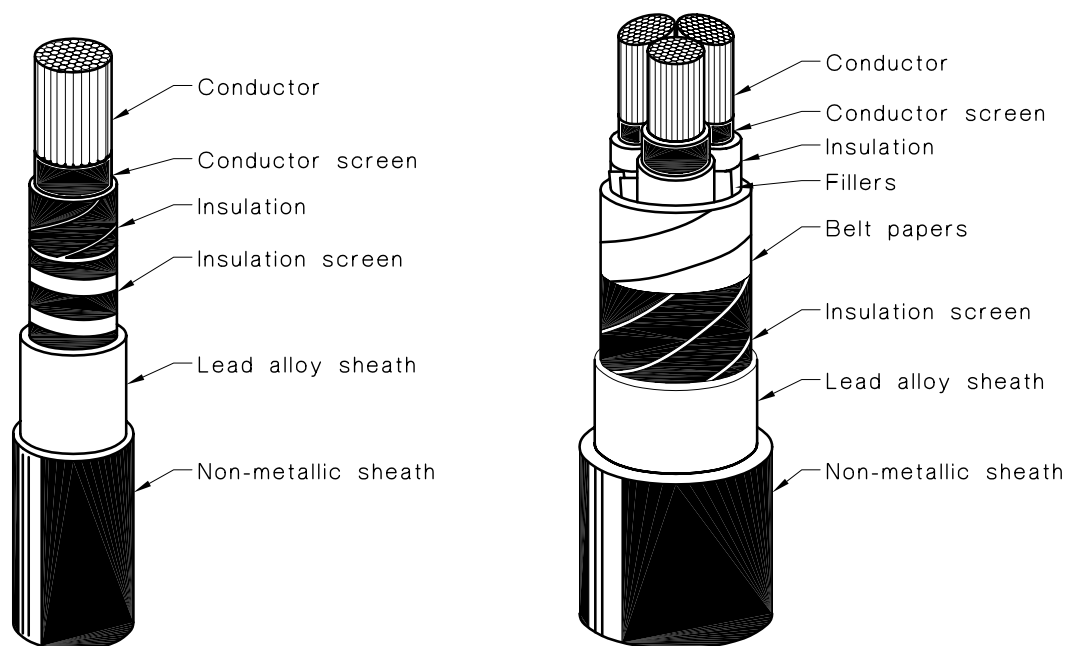
TABLE 1
MAXIMUM CONTINUOUS CONDUCTOR TEMPERATURES

Voltage rating of cable kV	Type of cable	Maximum temperature °C
0.6/1 (1.2) 3.8/6.6 (7.2)	All types	80
6.35/11 (12)	Single-core	70
	Three-core screened	70
11/11 (12)	Three-core belted	65
12.7/22 (24) 19/33 (36)	All types	65

NOTE: The temperatures given in this table are only for cables laid either direct in the earth or in thermal conditions equivalent to direct burial. Reference should be made to ERA 69.30, Part 1 for temperatures relating to other conditions of operation.

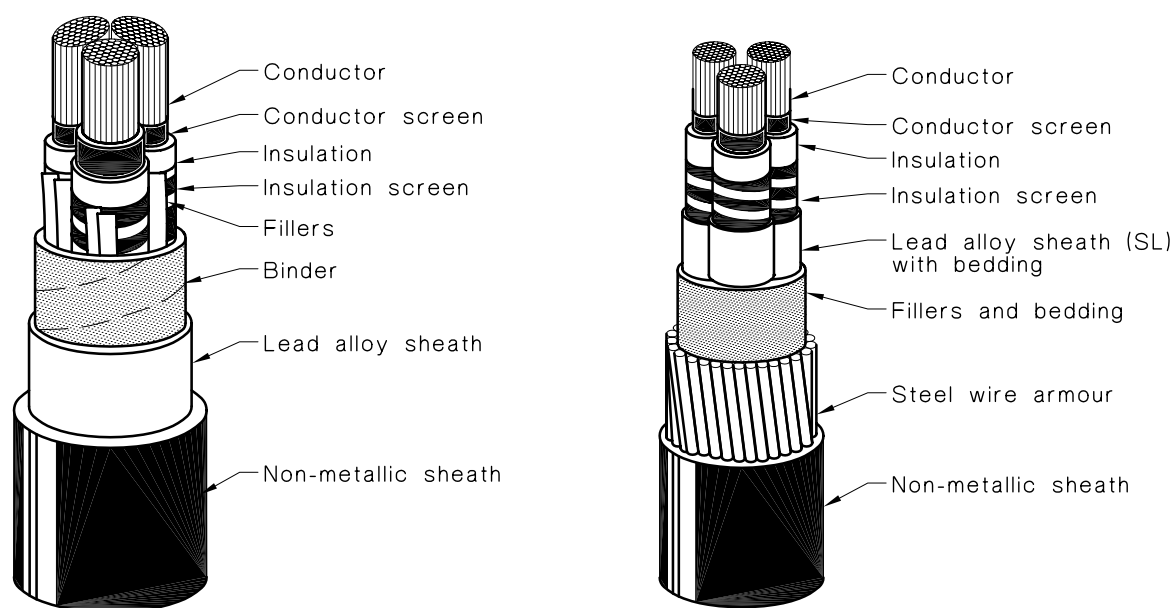
6 CONDUCTORS

Conductors shall be either plain annealed copper or aluminium of the type indicated in Tables 8 to 22 and shall comply with AS/NZS 1125.



(a) Single core

(b) Three-core belted



(c) Three-core screened

(d) Three-core SL

FIGURE 1 TYPICAL CONSTRUCTIONS OF IMPREGNATED PAPER INSULATED CABLES

7 CONDUCTOR SCREEN

Cables having a rated voltage of 6.35/11 (12) kV and above shall have a screen on each conductor. This shall comprise two layers of semiconductive carbon-loaded paper tape having a total approximate thickness of 0.2 mm. The two layers shall be applied helically in the same direction and breaking joint.

8 INSULATION

8.1 General

The conductors (screened where required by Clause 7) shall be insulated with layers of paper tape.

For belted cables, further layers of paper tape shall be applied over the laid-up cores in accordance with Clause 11.1.

8.2 Material

The paper used for cable insulation shall be long fibred and uniform in texture. It shall be free from dark spots, and shall contain no imperfectly pulped materials, woody material, lime spots, metallic particles or other deleterious substances and shall comply with the requirements of Table 2.

8.3 Method of application

The paper tapes shall be applied helically. When applied in the same direction, successive layers shall be breaking joint so as to form a reasonably smooth and compact covering of uniform thickness. The registration shall be between 60/40 and 80/20. However, in cables rated 3.8/6.6 (7.2) kV and above, it is permissible to have a group of two or three coincident gaps in adjacent tapes but there shall be not more than two such groups at any one position in the insulation thickness.

8.4 Paper thickness

The thickness of the individual paper tapes of the core and belt insulation shall be not greater than 0.15 mm and 0.2 mm respectively.

8.5 Insulation thickness

Excluding all screen tapes, the insulation thickness determined in accordance with Clause 20.7 shall be not less than that specified in Tables 8 to 22.

9 CORE IDENTIFICATION

Multicore cables shall have the cores identified by numbers as shown below, printed in white on the outer layer of insulating paper or interleaved carbon-loaded insulation screen paper, as appropriate. The height of the figures shall be not less than 4.5 mm and they shall be spaced enough to provide complete and ready identification of all the cores in any 25 mm length of cable.

Any dyes used shall not fade unduly, be chemically neutral and have no injurious effect on the fibres of the paper.

The sequence of laying up the cores shall be as follows:

Cables	Numbered
0.6/1 (1.2) kV Four-core	0, 1, 2, 3
3.8/6.6 (7.2) kV and above Three-core	1, 2, 3

NOTE: The numbers '1', '2' and '3' are intended to indicate phase conductors and '0' the neutral.

10 INSULATION SCREEN

10.1 General

The cores of the following cables shall be screened:

- (a) Single-core cables having a rated voltage of 6.35/11 (12) kV and above.

- (b) Three-core cables having a rated voltage of 12.7/22 (24) kV and above.
- (c) Three-core cables having a rated voltage of 6.35/11 (12) kV and 11/11 (12) kV if the screened type is required.
- (d) Three-core SL cables having rated voltages of 12.7/22 (24) kV and 19/33 (36) kV.

10.2 Screen

In screened cables, a screen shall be applied over the insulation of each core. The screen shall consist of either a metallized paper tape incorporating a layer of aluminium approximately 0.013 mm thick, or a non-ferrous metal tape, approximately 0.075 mm thick, interleaved with a semi-conductive carbon-loaded paper tape.

10.3 Additional screening

Single-core cables which are screened with metallized paper and which have nominal conductor areas of 500 mm² and larger shall have a fabric tape incorporating interwoven copper wires applied over the screen.

11 LAYING UP

11.1 Belted cables

In belted cables, the cores shall be laid up together with paper, jute or other suitable fillers, and covered with further helically applied layers of paper insulation (see Clause 8) to form a compact and circular cable.

All 6.35/11 (12) kV and 11/11 (12) kV belted cables shall have a screen consisting of a semiconductive carbon-loaded paper tape, of approximate thickness 0.1 mm, helically applied with an overlap over the belt insulation.

11.2 Screened cables

In three-core screened cables, the screened cores shall be laid up together with paper, jute or other suitable fillers, and be helically lapped with a binder of fabric tape incorporating interwoven copper wires.

11.3 Screened SL cables

In screened SL cables, the sheathed cores, protected in the manner specified in Clause 15, shall be laid up together, interstices filled with compounded jute or other suitable non-hygroscopic fibrous material, e.g. fibrilated polypropylene, and have a binder of compounded hessian or equivalent tape applied over the laid-up cores.

11.4 Direction of lay

The direction of lay of the cores of multicore cables shall be right-hand.

12 IMPREGNATION

12.1 General

Drying and mass impregnation with an insulating compound shall be performed prior to lead alloy sheathing, so that the completed cable complies with Clauses 12.2 and 12.3.

12.2 Compound test

The compound shall meet the requirements of Table 2 for drainage and residual congealing point tests.

12.3 Breaking load and elongation at break of impregnated paper

When tested in accordance with Clause 20.11, all paper, after removal from the completed cable, shall comply with the requirements of Table 2.

13 LEAD ALLOY SHEATH

13.1 General

A lead alloy sheath shall be extruded over the impregnated cable. It shall be impervious to moisture and reasonably close-fitting.

13.2 Composition

The composition of the lead alloy sheath shall be alloy E in accordance with AS/NZS 2893.

13.3 Thickness

The nominal thickness (T_m) shall be as specified in Tables 8 to 22.

The minimum thickness at any point shall not fall below the nominal thickness by more than 5 percent of the nominal thickness plus 0.10 mm i.e.

$$\text{minimum thickness} = (0.95T_m - 0.10 \text{ mm})$$

13.4 External coating

A coating of bituminous compound shall be applied over the lead alloy sheath.

14 BEDDING (OPTIONAL)

14.1 General

Bedding shall be either lapped or extruded.

14.2 Lapped bedding

Lapped bedding under the armour shall have an approximate thickness of 1.5 mm after application of the armour.

Except in SL cables, lapped bedding shall consist of two compounded paper or synthetic tapes applied immediately over the previously compounded lead alloy sheath, followed by one or more layers of suitable compounded fibrous materials applied either with or without additional compound as specified in Clause 17.

The additional compound need not be applied in the case of bright wire armoured cables or armoured cables having a non-metallic sheath.

In SL cables, one compounded paper tape and either one compounded cotton or synthetic fibre tape shall be applied over each of the previously compounded metallic sheathed cores, followed over the laid-up cores by one or more layers of suitably compounded fibrous materials applied with additional compound as specified in Clause 17.

14.3 Extruded bedding

14.3.1 Material

Extruded bedding shall consist of a covering of 4V-75, PE or LLDPE, in accordance with AS/NZS 3808 applied over the metallic sheath. A thin layer of bituminous compound shall be applied over the metallic sheath before application of the extruded bedding.

14.3.2 Thickness

The nominal thickness (t_B) shall be as specified in Tables 8, 10, 13, 14, 15, 16, 18 or 21.

The minimum thickness at any point shall not fall below the nominal thickness by more than 15 percent of the nominal thickness plus 0.10 mm, i.e.

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

15 ARMOUR (OPTIONAL)

15.1 General

When armouring of multicore cables is required, it shall consist of either—

- (a) one layer of galvanized steel wire (single-wire armour) applied over the bedding; or
- (b) two layers of galvanized steel wire (double-wire armour) applied over the bedding.

NOTE: Although the steel tape armour is not covered in this Standard, its use is not precluded. Any steel tape armour shall meet the requirements of BS 6480.

15.2 Single-wire armour

The armour shall normally consist of a single layer of galvanized steel wires of the size specified in Tables 8, 10, 13, 14, 15, 16, 18, 19, 21 and 22.

The galvanized steel wire shall comply with AS/NZS 3863. Where joints in armour wire are necessary they shall be brazed or welded and any surface irregularity be removed. A joint in any wire shall be not less than 1 m from the nearest joint in any other armour wire in the completed cable.

The direction of lay of the armour shall be left-hand.

15.3 Double-wire armour

A double layer of armour wires shall be provided. The size of wire used for both layers shall be the same as that for single-wire armoured cable specified in Tables 8, 10, 13, 14, 15, 16, 18, 19, 21 and 22. The requirements of Clause 15.2 for quality and joints shall apply.

The direction of lay of the inner layer of armour shall be left-hand. The direction of lay for the outer layer of armour shall be right-hand.

There shall be a separator consisting of a layer of suitable compounded fibrous material between the two layers of armour applied either with or without additional compound as specified in Clause 17.

16 NON-METALLIC SHEATH OR SERVING

16.1 Non-metallic sheath

16.1.1 Material

The non-metallic sheath shall consist of extruded 4V-75, HDPE, PE or LLDPE, in accordance with AS/NZS 3808. Where a d.c. test is specified (see Appendix C), an outer graphite coating shall be applied over the non-metallic sheath.

16.1.2 Thickness

The average thickness of the non-metallic sheath, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness (t_s) specified in Tables 8 to 22 and the minimum thickness at any point shall not fall below the specified thickness by more than—

- (a) for unarmoured cables 15 percent of the specified thickness plus 0.10 mm, i.e.
minimum thickness = $(0.85 t_s - 0.10 \text{ mm})$
- (b) for armoured cables 20 percent of the specified thickness plus 0.10 mm, i.e.
minimum thickness = $(0.80 t_s - 0.10 \text{ mm})$

16.2 Serving for armoured cables

The serving shall consist of one or more layers of suitable compounded fibrous materials applied over the compounded armour with additional compound applied over each layer (see Clause 17).

The thickness shall be approximately 2.0 mm.

To prevent adhesion between layers of cable on the delivery drum, a coating of whitewash or other suitable material shall be applied to the outside of the cable.

17 COMPOUNDS FOR LAPPED BEDDING AND SERVING

Compounds used in the protective bedding and serving shall be of such a nature that in the completed cable they do not crack or run at any temperature likely to be attained in transit to or storage at the site, or when the cables are in operation.

The compound shall adhere properly to the armour and lead alloy sheath so that if the coverings are unwrapped it shall be evident that the metal surfaces were completely covered by the closely adherent compound before removal of the wrappings. Care shall be taken to ensure that the amount of compound applied is retained evenly around the cable. The compounds shall have no deleterious effect on the lead alloy sheath, armour or protective coverings. They shall be derived from bitumen and be free from the distillation products of coal or wood.

18 CABLE MARKINGS

18.1 End markings

The end of three- or four-core cable at which the rotational sequence of the cores is clockwise shall be coloured red and the other end shall be coloured green.

18.2 Identification of cables

A tape printed at intervals not greater than 300 mm with the manufacturer's name and the year of manufacture shall be provided throughout the length of the cable under the metal sheath.

18.3 Marking of non-metallic sheath

Where the cable is provided with a non-metallic sheath, it shall be marked with the following:

- (a) A registered name or registered mark, which enables the manufacturer or supplier of the cable to be identified.
- (b) Year of manufacture.
- (c) Conductor size and material.
- (d) The words 'ELECTRIC CABLE' and the voltage rating e.g. 3.8/6.6 kV.

The letters and figures shall consist of upright block characters arranged along two or more lines approximately equally spaced around the circumference of the cable. The size of the letters and numerals shall be not less than 15 percent of the nominal overall diameter of the cable but in no case less than 3 mm or greater than 13 mm. The gap between the end of one set of characters and the beginning of the next shall be not greater than 150 mm.

18.4 Metre marking on non-metallic sheath

The cable shall be metre marked in a contrasting colour with the lowest number at the inner end of the delivery drum.

19 SEALING AND PREPARATION FOR DELIVERY

19.1 General

The cable shall be wound onto drums meeting the requirements of AS/NZS 2857 for timber drums or AS 3983 for metal drums. Before despatch, the manufacturer shall seal both ends of the cable so as to prevent the ingress of water during transportation and storage.

Ends of the cable projecting from the drum shall also be protected from mechanical damage (see also Appendix C).

Each drum shall be durably marked with a distinguishing number on the outside of the flange and particulars of the cable, i.e. voltage, length, conductor size and cable type. The gross mass shall be shown and the direction of rolling shall be indicated by an arrow.

20 TESTS

20.1 General

Cable shall be subjected to the tests set out in Table 2.

The tests shall be performed at room temperature unless otherwise specified.

TABLE 2
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	Conductor (a) All appropriate tests, with the exception of resistance, on conductors taken from the completed cable (b) Conductor resistance	As specified in AS/NZS 1125 for the appropriate conductor As specified in AS/NZS 1125	 Routine	 AS/NZS 1660.3
2	Insulation (a) Measurement of thickness (b) Water soluble chemical impurities (c) Conductivity of aqueous extract (d) pH value of aqueous extract (e) Ash content (f) Breaking load and elongation at break	Compliance with Tables 8 to 22 and Clause 8.5 Shall not exceed 1% by mass Shall not exceed 6 mS/m Shall not be less than 6.0 and not more than 8.0 Shall not exceed 1.5% Minimum tensile strength: 43.3 MPa Minimum elongation at break: 1.5%	Sample Sample Sample Sample Sample Sample	Clause 20.6 Appendix F IEC 60554-2 IEC 60554-2 IEC 60554-2 Clause 20.11
3	Lead alloy sheath (a) Material analysis (b) Measurement of thickness	The chemical composition shall comply with the requirements of Clause 13.2 Compliance with Clause 13.3	Sample Sample	AS/NZS 2893 Appendix E
4	Extruded bedding Measurement of thickness	Compliance with Clause 14.3.2	Sample	Appendix E
5	Armour Measurement of wire armour diameter	Compliance with Tables 8, 10, 13, 14, 15, 16, 18, 19, 21, 22 and Clause 15	Sample	AS/NZS 1660.1 and AS/NZS 3863
6	Non-metallic sheath (a) Measurement of thickness (b) Spark test on non-metallic sheath without graphic coating	Compliance with Tables 8 to 22 and Clause 16.1.2 No breakdown	Sample Routine	AS/NZS 1660.2.1 AS/NZS 1660.3 as for insulation

(continued)

TABLE 2 (continued)

7	Cable			
	(a) High voltage a.c. test for 5 min. NOTE: For 19/33 (36) kV cables, this test is to be performed after Test 8(a)	No breakdown	Routine	Clause 20.4
	(b) High voltage d.c. test on non-metallic sheath with graphite coating	The sheath shall withstand d.c. voltage of 8 kV/mm of nominal thickness for 1 minute	Sample	Clause 20.6
	(c) Bending test	Table 3	Sample	Clause 20.8
	(d) Drainage test	After 168 h maximum drainage shall not exceed the requirements of Table 7	Sample	Clause 20.9
	(e) Residual compound congealing point test	Any residual compound from the drainage test 7(d) shall not flow at ambient temperature. The congealing point shall be not less than 50°C	Sample	Clause 20.10
8	Additional tests for 19/33 (36) kV cables			
	(a) Dielectric dissipation factor ($\tan \delta$) measurement as a function of the voltage at ambient temperature	Maximum $\tan \delta$ at 0.5 U_0 : 0.003 Maximum increment of $\tan \delta$ between 0.5 and 1.25 U_0 : 0.002 Maximum increment of $\tan \delta$ between 1.25 and 2.0 U_0 : 0.004	Routine	Clause 20.5
	(b) Loading cycle test	A graphical interpretation of the $\tan \delta$ measurements shall not show any tendency towards a progressive increase	Type	Appendix G
	(c) Impulse voltage test	No breakdown	Type	Appendix G
9	Cable pressure test*	Pressure shall not exceed 250 kPa	Type	Appendix H

* An alternative test method and pass criteria may be agreed between the purchaser and the supplier.

20.2 Test categories

For the purpose of this Standard the tests are divided into three categories:

(a) Routine tests

Tests made by the manufacturer on all production lengths of completed cables to demonstrate the integrity of the cable. By agreement between the purchaser and the manufacturer, routine tests may be wholly or partly omitted on the drum lengths cut from the finished production length of cable.

(b) Sample tests

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

These tests are only made if requested by the purchaser at the time of ordering.

(c) Type tests

Tests made by the manufacturer before supplying on a general commercial basis a type of cable covered by this Standard, to demonstrate satisfactory performance characteristics to meet the intended application. These tests are of such a nature 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.

The category of each test referred to in this Clause is indicated in Table 2.

20.3 Measurement of conductor resistance

The d.c. resistance of each conductor shall be measured together with the temperature of the cable at the time of measurement.

The results, when corrected to 20°C, shall meet the requirements of AS/NZS 1125.

20.4 Voltage tests

20.4.1 Test

All completed cable shall be subjected to the voltage tests as detailed in Table 3 (for 19/33 (36) kV cables see also Clause 20.5).

The test shall be at room temperature with an alternating voltage having a frequency in the range 40 to 62 Hz. Its waveform shall approximate to a sine curve and have both half cycles reasonably alike. The voltage shall be increased gradually and maintained at full value for five minutes.

20.4.2 Requirement

There shall be no breakdown of the insulation.

TABLE 3
TEST VOLTAGE ON COMPLETED CABLE

1	2	3	4
Voltage designation	Alternating test voltage (r.m.s.)		
	Belted cables		Single-core and screened cables
	Between conductors	Between any conductor and sheath	Between any conductor and sheath
kV	kV	kV	kV
0.6/1 (1.2)	3.5	3.5	3.5
3.8/6.6 (7.2)	17	9.8	10.0
6.35/11 (12)	25	14.4	15
11/11 (12)	25	25	25
12.7/22 (24)	—	—	30
19/33 (36)	—	—	45

20.5 Dielectric dissipation factor (DDF)

20.5.1 Test

This test is applicable only to 19/33 (36) kV cables, and shall be made before the voltage test in Clause 20.4, with alternating voltage having a frequency in the range of 40 to 62 Hz. Its waveform shall approximate to a sine curve and have both cycles reasonably alike.

The DDF of the insulation shall be measured at ambient temperature, as follows:

- If the measurements are made at a temperature below 20°C, the results shall be corrected to 20°C, either by subtracting from the measured value 2 percent of this value per degree Celsius of the difference between the test temperature and 20°C, or by the use of a correction curve appropriate to the insulation, if agreement on such a curve has been reached between the purchaser and the manufacturer.
- No correction shall be made if the test temperature is 20°C or greater.

The test shall be made at 0.5, 1.25 and 2.0 times U_0 , i.e. 9.5 kV, 24 kV and 38 kV.

The test shall be applied between each conductor in turn and the other conductors connected to the lead alloy sheath. The measurements shall be made with a Schering bridge, using a loss-free capacitor as the standard.

The measurement shall be taken within 5 s and 15 s of applying the designated voltages. Measurement after 15 s shall be invalid.

NOTE: Re-test following invalid measurement should be delayed by at least 24 h.