

Australian/New Zealand Standard™

**Electric cables—Twisted pair for control  
and protection circuits**

### **AS/NZS 2373:2003**

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 2 September 2003 and on behalf of the Council of Standards New Zealand on 9 September 2003. It was published on 29 October 2003.

---

The following are represented on Committee EL-003:

Australasian Railway Association  
Australian Electrical and Electronic Manufacturers Association  
Australian Industry Group  
Canterbury Manufacturers Association, New Zealand  
Department of Defence (Australia)  
Department of Mineral Resources N.S.W.  
Electrical Contractors Association of New Zealand  
Electrical Regulatory Authorities Council  
Electricity Supply Association of Australia  
Institution of Engineers Australia  
Ministry of Economic Development (New Zealand)  
National Electrical and Communications Association

---

#### **Keeping Standards up-to-date**

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 Standards may also be withdrawn.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

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Australia web site at [www.standards.com.au](http://www.standards.com.au) or Standards New Zealand web site at [www.standards.co.nz](http://www.standards.co.nz) and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

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

---

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

---

**RECONFIRMATION**

**OF**

**AS/NZS 2373:2003**

**Electric cables—Twisted pair for control and protection circuits**

---

**RECONFIRMATION NOTICE**

Technical Committee EL-003 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 10 October 2016.

Approved for reconfirmation in New Zealand on behalf of the Standards Council of New Zealand on 13 December 2016.

The following are represented on Technical Committee EL-003:

Australian Cable Makers' Association  
Australian Industry Group  
Electrical Compliance Testing Association  
Electrical Regulatory Authorities Council  
National Electrical and Communications Association  
Queensland University of Technology

## NOTES

Australian/New Zealand Standard™

**Electric cables—Twisted pair for control  
and protection circuits**

Originated as AS 2373.2—1982.  
Previous edition AS/NZS 2373.2:1995.  
Jointly revised and redesignated as AS/NZS 2373:2003.

**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 5509 7

## PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-003, Electric Wires and Cables to supersede AS/NZS 2373.2:1995, *Electric cables for control and protection circuits, Part 2: Twisted pair control cables*.

The objective of this Standard is to specify the construction, dimensions and tests for cables used for control, supervisory, protection and instrumentation circuits, with or without a support wire.

This Standard differs from the 1995 edition as follows:

- (a) The specified range of conductor cross-sectional areas has been amended.
- (b) The application of collective insulation, moisture barrier sheath, metallic sheath, armour and insect-resistant barrier have been nominated as optional processes.
- (c) The preferred range of cables has been reduced.
- (d) The approximate overall diameters have been deleted.

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.

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

## CONTENTS

	<i>Page</i>
1 SCOPE .....	4
2 REFERENCED DOCUMENTS .....	4
3 DEFINITIONS .....	4
4 VOLTAGE DESIGNATION .....	5
5 CONDUCTORS .....	5
6 INSULATION .....	5
7 LAY-UP .....	6
8 FILLERS AND TAPES .....	6
9 COLLECTIVE INSULATION (OPTIONAL) .....	7
10 METALLIC SCREEN .....	7
11 MOISTURE BARRIER SHEATH (OPTIONAL) .....	7
12 METALLIC SHEATH (OPTIONAL) .....	7
13 ARMOUR (OPTIONAL) .....	8
14 NON-METALLIC SHEATH .....	8
15 INSECT-RESISTANT BARRIER (OPTIONAL) .....	8
16 SUPPORT WIRES .....	9
17 MARKING .....	10
18 TESTING .....	10
19 GUIDE TO BENDING RADIUS .....	10
APPENDICES	
A PURCHASING GUIDELINES .....	13
B TYPICAL LAY-UP FORMATIONS .....	14
C THE FICTITIOUS CALCULATION METHOD FOR THE DETERMINATION OF THE DIMENSIONS OF PROTECTIVE COVERINGS .....	15
D NON-METALLIC SHEATH THICKNESS OF PREFERRED RANGE OF CABLES .....	19
E SUPPORT WIRE SIZE AND APPROXIMATE LINEAR MASS FOR PREFERRED RANGE OF CABLES .....	20
F GUIDE TO BENDING RADIUS OF NON-AERIAL CABLES .....	21
G HIGH VOLTAGE TEST .....	22

## STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

**Australian/New Zealand Standard****Electric cables—Twisted pair for control and protection circuits****1 SCOPE**

This Standard specifies requirements for screened polyethylene (PE) insulated twisted pair control cables for voltages up to and including 0.6/1 kV. A support wire is included for aerial cables.

It applies to cables intended for use in control, supervisory, protection and instrumentation circuits and includes cables commonly referred to as pilot cables. Control cables complying with this Standard may be used between power stations, substations or in industrial applications.

It does not apply to cables used solely for telecommunication purposes.

NOTE: Purchasing guidelines are contained in Appendix A.

**2 REFERENCED DOCUMENTS**

The following documents are referred to in this Standard:

## AS

- |        |   |
|--------|---|
| 1222   | Steel conductors and stays—Bare overhead                        |
| 1222.1 | Part 1: Galvanized (SC/GZ)                                      |
| 2706   | Numerical values—Rounding and interpretation of limiting values |

## 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  |
| 1660.5.6 | Method 5.6: Fire tests—Test for combustion propagation  |
| 3808     | Insulating and sheathing materials for electric cables  |
| 5000     | Electric cables—Polymeric insulated   |
| 5000.1   | Part 1: For working voltages up to and including 0.6/1 kV   |

**3 DEFINITIONS**

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

**3.1 Control cable**

A cable used for control, measuring, protection and communication circuits.

**3.2 Lay-up**

The assembling of cores.

**3.3 Routine tests**

Tests made by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements.

### 3.4 Sample tests

Tests made by the manufacturer on samples of completed cable, or components taken from a completed cable, to verify that the finished product meets the design specification.

### 3.5 Type tests

Tests made 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.

### 3.6 Voltage designation

For cables for a.c. systems, the rated voltages  $U_0$  and  $U$  expressed in the form  $U_0/U$ ; or for cables for d.c. systems, the rated voltage  $U_0$ —

where

$U_0$  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; and

$U$  is the r.m.s. power frequency voltage between phases of the supply system for which the cable is designed.

### 3.7 Wavelength or length of lay

The axial distance between successive crests of the waveform or turns of the helix formed by a core of a pair or pairs of twisted pair cable.

## 4 VOLTAGE DESIGNATION

The rated voltage  $U_0/U$  recognized for the purpose of this Standard is 0.6/1 kV.

## 5 CONDUCTORS

Conductors shall be of single wire plain annealed copper and shall comply with the relevant requirements of AS/NZS 1125 and the maximum d.c. resistance at 20°C as given in Table 1.

TABLE 1

MAXIMUM d.c. RESISTANCE AT 20°C OF SOLID CIRCULAR CONDUCTORS

Nominal cross-sectional area of conductor mm <sup>2</sup>	Nominal diameter of wire mm	Maximum d.c. resistance at 20°C Ω/km
0.64	0.90	28.3
1.0	1.13	18.1
1.27	1.27	14.3
1.5	1.38	12.1

## 6 INSULATION

### 6.1 Material

The insulation material shall be PE complying with AS/NZS 3808.

### 6.2 Application

The insulation shall be homogeneous and applied with a close fit, but shall not adhere to the conductor.

### 6.3 Thickness

The average thickness of insulation, determined by the method specified in AS/NZS 1660.2.1, shall be not less than the thickness ( $t_i$ ) specified in Table 2 and the minimum thickness at any point shall not fall below the specified thickness by more than 10 percent of the specified thickness plus 0.1 mm, i.e.

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

**TABLE 2**  
**INSULATION THICKNESS**

Nominal cross-section area of conductor  mm <sup>2</sup>	Insulation thickness ( $t_i$ )  mm
0.64	0.8
1.27	0.8
1.0	0.8
1.5	0.8

### 6.4 Identification of twisted pairs

When the twisted pairs in the cable are identified by colours, the colour coding of the pairs shall progress in sequence from the centre of the cable as given in Table 3.

Alternatively, each pair may contain a black and a white insulated core. One or both cores in each pair shall be numbered in a contrasting colour. The numbering of pairs shall progress in sequence from the centre of the cable.

**TABLE 3**  
**COLOUR CODE FOR TWISTED-PAIR CABLES**

Centre or layers	Insulation						
	Pair 1	Pair 2	Pair 3	Pair 4	Pair 5	Pair 6	Last pair
1-pair centre	Orange- white						
2-pair centre	Orange- white	Violet- black					
3-pair centre	Orange- white	Red-grey	Violet- black				
4-pair centre	Orange- white	Red-grey	Blue- brown	Violet- black			
Layers	Orange- white	Red-grey	Blue- brown	Red-grey	Blue- brown	*	Violet black

\* Pair colours shall repeat from red-grey.

## 7 LAY-UP

An adequate number of separate, identifiable lengths of lay of twisted pairs shall be used to minimize crosstalk.

NOTE: Typical lay-up formations are shown in Appendix B.

## 8 FILLERS AND TAPES

Fillers, binder and wrapping tapes shall be of suitable non-metallic materials compatible with the other materials of the cable with which they are in contact.

Wrapping tape(s) shall be applied with a minimum of 10 percent overlap around the laid up core assembly.

## **9 COLLECTIVE INSULATION (OPTIONAL)**

### **9.1 Material**

The collective insulation shall be PE complying with AS/NZS 3808.

### **9.2 Application**

The collective insulation shall be applied over the taped laid-up pairs.

### **9.3 Thickness**

The average thickness of insulation, determined by the method specified in AS/NZS 1660.2.1, shall not be less than 1.5 mm and the minimum thickness at any point shall be not less than 1.30 mm.

NOTE: This requirement is designed to allow cables to withstand a voltage (under fault conditions) of 15 kV a.c. r.m.s. between the screen and the cores.

## **10 METALLIC SCREEN**

### **10.1 General**

The metallic screen shall be either a collective screen consisting of a tape or tapes applied helically over the collective insulation or a moisture barrier sheath (see Clause 11).

### **10.2 Collective screen application**

For a single tape a minimum overlap of 15 percent shall be provided. For more than one tape a gap may be used in each tape, provided the following tape is positioned centrally over the gap in the underlying tape.

### **10.3 Collective screen material**

The screen material shall consist of copper, brass or aluminium tape having a minimum thickness of 0.070 mm or aluminium/polyester laminated tape having a minimum aluminium thickness of 0.023 mm.

### **10.4 Continuity conductor (drain wire)**

Where an aluminium or aluminium/polyester helical tape is incorporated in the cable, a tinned copper stranded continuity conductor consisting of seven wires of at least 0.25 mm nominal diameter shall be included and it shall be in contact with the aluminium surface of the tape. It may be applied longitudinally and shall be continuous throughout the length of the cable.

## **11 MOISTURE BARRIER SHEATH (OPTIONAL)**

The moisture barrier sheath shall consist of an aluminium laminated tape, longitudinally applied with a minimum overlap of 5 mm and an extruded layer of PE complying with AS/NZS 3808.

The thickness of the aluminium layer shall be approximately 0.15 mm and the composite thickness of the laminated tape shall be approximately 0.2 mm.

The overall thickness of the moisture barrier sheath shall comply with the requirements of a non-metallic sheath in AS/NZS 5000.1.

## **12 METALLIC SHEATH (OPTIONAL)**

The metallic sheath shall be in accordance with AS/NZS 5000.1 and shall be applied over a bedding complying with AS/NZS 5000.1. A moisture barrier sheath may be used as a bedding.

The fictitious diameter under the bedding and the sheath shall be calculated using the method in Appendix C.

### 13 ARMOUR (OPTIONAL)

The armour shall be in accordance with AS/NZS 5000.1 and shall be applied over a separation layer complying with AS/NZS 5000.1. A moisture barrier sheath may be used as a separation layer.

The fictitious diameter under the armour shall be calculated using the method in Appendix C.

### 14 NON-METALLIC SHEATH

#### 14.1 Material

The sheath shall be black and either PE, 4V-75 or HFS-75-TP complying with AS/NZS 3808.

#### 14.2 Construction

##### 14.2.1 General

The sheath shall fit closely over the underlying component (e.g. armour, screen) but, with the exception of a moisture barrier, shall not adhere to such underlying component.

##### 14.2.2 Aerial cable

The sheath shall contain a steel support wire and shall be of ‘cottage-loaf’ configuration (see Figure 1).

The sheath shall fit closely over but not adhere to the screen nor to the support wire.

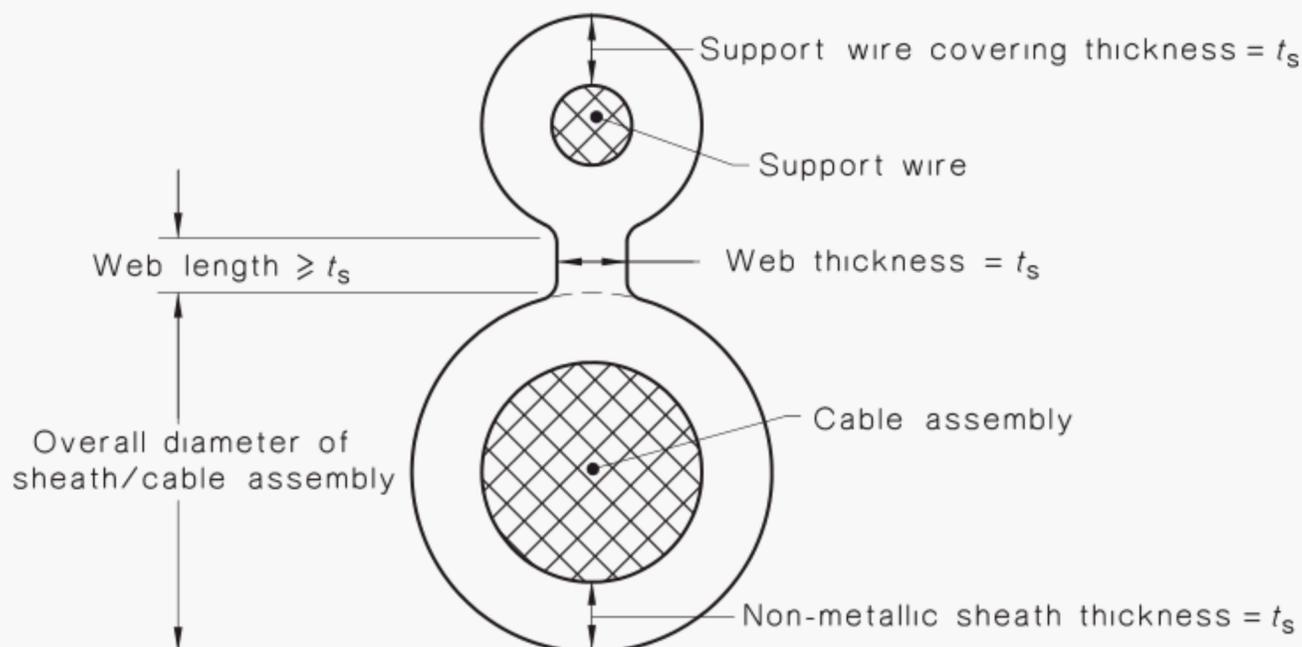


FIGURE 1 AERIAL CONTROL CABLE CONSTRUCTION

#### 14.3 Thickness

The thickness shall comply with the requirements of AS/NZS 5000.1.

For the preferred range of cables the thicknesses are given in Appendix D.

#### 14.4 Web dimensions

The length and thickness are shown in Figure 1, where  $t_s$  is the non-metallic sheath thickness.

### 15 INSECT-RESISTANT BARRIER (OPTIONAL)

A polyamide jacket shall be applied as an insect-resistant barrier. The material shall be polyamide 11 or 12.

When determined in accordance with AS/NZS 1660.2.1 for non-metallic sheath, the thickness of the polyamide shall be not less than 0.20 mm at any point.

The polyamide, if unprotected, is susceptible to damage during installation. Therefore it may be inserted within the combined layers of the sheath or covered by other cable components.

Where the polyamide jacket is the outermost layer it shall be black and contain UV stabilizers.

NOTE: Polyamide jacketed cables without a protective layer are unlikely to pass the Combustion Propagation Test.

## 16 SUPPORT WIRES

### 16.1 Material

Stranded galvanized steel wire shall be in accordance with AS 1222.1, except that the 7/1.60 size is not included in AS 1222.1, and the additional information required for this size has therefore been provided in Tables 4 and 5.

**TABLE 4**  
**PROPERTIES OF GALVANIZED STEEL WIRE**

1	2	3	4	5	6	7
Diameter			Cross-sectional area mm <sup>2</sup>	Approx. mass per km kg	Min. breaking load kN	Typical d.c. resistance per km at 20°C Ω
Nom. mm	Max. mm	Min. mm				
1.60	1.63	1.57	2.0	16.0	2.64	84

**TABLE 5**  
**PROPERTIES OF 7/1.60 SUPPORT WIRE**

1	2	3	4	5	6
Stranding and wire diameter mm	Approx. overall diameter mm	Cross-sectional area mm <sup>2</sup>	Approx. mass per km kg	Calculated breaking load kN	Typical d.c. resistance per km at 20°C Ω
7/1.60	4.80	14.0	113	17.5	12.3

### 16.2 Dimensions

The size of support wire shall be calculated on the basis of span, wind speed, ambient temperature range, sag and minimum safety factor. Guidance should be sought from manufacturers regarding the suitability of the support wire for any particular installation.

NOTE: Appendix E provides the support wire size and mass of cable for the preferred range of cables.

## 17 MARKING

### 17.1 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) Cables designed for specific applications will be marked accordingly, e.g. Aerial cables will be marked with the word 'AERIAL', cables suitable for d.c. application only will be marked with the words 'FOR D.C. USE ONLY'.

### 17.2 Means of marking

Means of marking are as follows:

- (a) Marking on outer surface

The marking shall consist of printing, reproduction in relief (embossing) or stamping (indenting). The distance between the end of one block of marking and the beginning of the next shall not exceed 550 mm.

- (b) Marking on tape

The marking shall consist of printing on a tape which is included throughout the length of the cable. The distance between the end of one block or marking and the beginning of the next shall not exceed 275 mm.

### 17.3 Marking of packaging

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

- (a) The registered name or registered mark which enables the manufacturer or supplier to be identified.
- (b) The voltage rating.
- (c) The size of support wire (stranding and wire diameter), conductor size and number of pairs as applicable.
- (d) Identification of insulation and sheath.
- (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.

## 18 TESTING

Cables shall comply with the tests specified in Table 6.

## 19 GUIDE TO BENDING RADIUS

NOTE: See Appendix F.

**TABLE 6**  
**TESTS—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 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 cable	As specified in AS/NZS 3808		
3	All appropriate tests on non-metallic sheath taken from or measured on the cable	As specified in AS/NZS 3808		
4	Conductor resistance	Compliance with the requirements of Table 1 or AS/NZS 1125 as appropriate	Routine	AS/NZS 1660.3
5	Measurement of insulation thickness	Compliance with the requirements of Clause 6.3	Sample	AS/NZS 1660.2.1
6	Measurement of thickness of non-metallic sheath, separation sheath, collective insulation and insect-resistant barrier	Compliance with the respective requirements of Clauses 14.3, 13, 9.3, and 15	Sample	AS/NZS 1660.2.1
7	Measurement of metallic sheath thickness	Compliance with the requirements of Clause 12	Sample	AS/NZS 1660.1
8	Measurement of armour dimensions	Compliance with the requirements of Clause 13	Sample	AS/NZS 1660.1
9	Measurement of support wire	Compliance with the requirements of Clause 16, and Tables 4 and 5		
10	Spark test on cores during insulating and twinning	No breakdown	Routine	AS/NZS 1660.3
11	Spark test on non-metallic sheath over metallic screens and support wire, where provided	No breakdown with metallic screen and support wire connected together, where provided	Routine	AS/NZS 1660.3
12	High voltage test for 1 min			Appendix G
12(a)	Test voltage shall be applied between each conductor and all remaining conductors	No breakdown at— 10 kV a.c. r.m.s. or 15 kV d.c.	Routine	
12(b)	Test voltage shall be applied between all conductors bunched together and the screen	No breakdown at— 15 kV a.c. r.m.s. or 23 kV d.c.	Routine	

(continued)

**TABLE 6** (continued)

1	2	3	4	5
Test No.	Test	Pass criteria	Category of test	Reference for test method
13	Combustion propagation test (see Notes 1 and 2) (Not applicable to polyethylene sheathed cables)	The cable shall be self-extinguishing. After all burning has ceased, the surface of the sample shall be wiped clean, and the charred or otherwise affected portion shall not extend to within 50 mm of the lower edge of the clamp fitted at the top. During the test, any falling particles shall not ignite the tissue paper underlay	Type	AS/NZS 1660.5.6

## NOTES:

- Application to assessment of fire hazard* The test provides direct data as to 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 materials, 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 must 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 (e.g. in high vertical runs of bunches of cables). Special installation precautions may have to be taken as it cannot be assumed that a bunch of cables will behave in the same way as a single cable.
- Reporting of results* When reporting the results, the following cautionary note shall be added:

Individual items of this test report should not be quoted in isolation as proof of product acceptability nor applied to directly assess performance under conditions other than those envisaged by the reference Specification, e.g. individual fire tests to prove an overall acceptable fire hazard level.

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 Standard, i.e. AS/NZS 2373.
- (b) Length of cable required and individual drum lengths.
- (c) Size and details of support wire, if required.
- (d) Number of pairs.
- (e) Method of pair identification.
- (f) Conductor size and construction.
- (g) Type of screen.
- (h) Whether metallic sheath or moisture barrier is required.
- (i) Type of armour, if required.
- (j) Type of sheath.
- (k) Whether insect resistant barrier is required.
- (l) Whether metre marking is required.

APPENDIX B  
TYPICAL LAY-UP FORMATIONS  
(Informative)

**TABLE B1**  
**TYPICAL LAY-UP FORMATIONS**

Cable size	Number of pairs in centre and successive layers					
	Centre	1st	2nd	3rd	4th	5th
10-pair	2	8	—	—	—	—
30-pair	4	10	16	—	—	—
50-pair	3	9	16	22	—	—
100-pair	2	8	14	20	25	31

## APPENDIX C

### THE FICTITIOUS CALCULATION METHOD FOR THE DETERMINATION OF THE DIMENSIONS OF PROTECTIVE COVERINGS

(Normative)

#### C1 INTRODUCTION

The thicknesses of cable coverings such as sheaths and armour have usually been related to nominal cable diameters by means of 'step tables'. This sometimes causes problems. The calculated nominal diameters are not necessarily the same as the actual values achieved in production. In borderline cases, queries can arise if the thickness of a covering does not correspond with the actual diameter, because the calculated diameter is slightly different. Variations in conductor make-up and shaped conductor dimensions between manufacturers, and different methods of calculation cause differences in nominal diameters, and may therefore lead to variations in the thicknesses of coverings used on the same basic design of cable.

To avoid these difficulties, the fictitious calculation method described in this Appendix was invented. The idea is to ignore the shape and degree of compaction of conductors and to calculate diameters from equations based on the cross-sectional area of conductors, insulation thickness and number of cores. Thicknesses of sheath and other coverings are then related to these diameters by equations or by tables. The method of calculating fictitious diameters is precisely specified and there is no ambiguity about the thicknesses of coverings to be used, which are independent of slight differences in manufacturing practices. This standardizes cable designs, thickness being recalculated and specified for each size of cable.

The fictitious calculation method is only used to determine dimensions of sheaths and cable coverings. It is not a replacement for the calculations of normal diameters required for practical purposes, which should be calculated separately.

#### C2 GENERAL

This Appendix adopts the fictitious method of calculating thicknesses of various coverings in a cable so that any differences which can arise in independent calculations are eliminated, e.g. the assumption of conductor dimensions and the unavoidable differences between nominal and actually achieved diameters.

All thickness values and diameters shall be rounded to the first decimal place according to the rules given in AS 2706.

Binder tapes, if not thicker than 0.3 mm, are ignored in this calculation method.

#### C3 METHOD

##### C3.1 Conductors

The fictitious diameter ( $d_L$ ) of conductor, calculated from the respective nominal cross-sectional area, irrespective of the conductor shape or compactness to be used in practice, is given in Table C1.

### C3.2 Cores

The fictitious diameter of a core ( $D_c$ ) of the respective conductor cross-sectional area is as follows:

$$D_c = D_L + 2t_i \quad \dots \text{C3.1}$$

where

$$t_i = \text{the average thickness of insulation}$$

**TABLE C1**

**FICTITIOUS DIAMETER OF CONDUCTOR**

Nominal cross-sectional area of conductor mm <sup>2</sup>	Fictitious diameter $d_L$ mm
0.64	0.9
1.0	1.1
1.27	1.3
1.5	1.4

### C3.3 Diameter over laid-up pairs

The fictitious diameter ( $D_f$ ) over laid-up pairs is given by the following:

$$D_f = \sqrt{N_p} \times k_{df} \times D_c \quad \dots \text{C3.2}$$

where

$$N_p = \text{number of pairs}$$

$$k_{df} = 2.03 \text{ for diameter factor of reverse layer construction}$$

$$= 1.97 \text{ for diameter factor of unidirectional layer construction}$$

$$D_c = \text{fictitious diameter of one of the pair cores}$$

### C3.4 Collective insulation

The fictitious diameter over the collective insulation ( $D_{bi}$ ) is given by:

$$D_{bi} = D_f + 3.0 \quad \dots \text{C3.3}$$

where

$$D_f = \text{the fictitious diameter over the laid up pairs}$$

### C3.5 Bedding

The fictitious diameter over the bedding ( $D_B$ ) is given by:

$$D_B = D_{uB} + 2t_B \quad \dots \text{C3.4}$$

where

$$t_B = 0.4 \text{ mm for fictitious diameters under the bedding } (D_{uB}) \text{ up to and including 40 mm}$$

$$= 0.6 \text{ mm for } D_{uB} \text{ exceeding 40 mm}$$

These fictitious values for  $t_B$  apply to all multipair cables whether or not a bedding is applied, unless a separation layer (complying with Clause 13) is used in place or in addition to the bedding when Paragraph C3.6 applies instead.

**C3.6 Moisture barrier**

The fictitious diameter over the moisture barrier ( $D_{mb}$ ) is given by the following equation:

$$D_{mb} = D_u + 0.4 \quad \dots \text{C3.5}$$

where

$$D_u = \text{the fictitious diameter under the moisture barrier}$$

**C3.7 Separation layer**

The fictitious diameter over the separation layer ( $D_{ss}$ ) is given by:

$$D_{ss} = D_u + 2t_{ss} \quad \dots \text{C3.6}$$

where

$$D_u = \text{the fictitious diameter under the separation layer}$$

$$t_{ss} = \text{the thickness calculated by the method given in AS/NZS 5000.1}$$

**C3.8 Metal sheath**

The fictitious diameter over the metal sheath ( $D_m$ ) is given by the following equation:

$$D_m = D_{um} + 2T_m \quad \dots \text{C3.7}$$

where

$$D_{um} = \text{the fictitious diameter under the metal sheath}$$

$$T_m = \text{the average thickness of the metal sheath}$$

**C3.9 Armour**

The fictitious diameter over the armour ( $D_x$ ) is given by the following equations:

(a) *Wire armour*

$$D_x = D_A + 2t_A \quad \dots \text{C3.8}$$

where

$$D_A = \text{the fictitious diameter under the armour}$$

$$= D_B$$

$$t_A = \text{the diameter of the armour wire}$$

(b) *Tape armour*

$$D_x = D_A + 4t_A \quad \dots \text{C3.9}$$

where

$$D_A = \text{the fictitious diameter under the armour}$$

$$= D_B$$

$$t_A = \text{the thickness of the armour tape}$$

**C3.10 Non-metallic sheath**

The fictitious diameter over the non-metallic sheath ( $D_s$ ) is given by:

$$D_s = D_u + 2t_s \quad \dots \text{C3.10}$$

where

$D_u$  = the fictitious diameter under the sheath

$t_s$  = the thickness of the non-metallic sheath

### **C3.11 Polyamide jacket**

The fictitious diameter over the polyamide jacket ( $D_j$ ) is given by:

$$D_j = D_u + 0.6 \quad \dots \text{C3.11}$$

where

$D_u$  = the fictitious diameter under the polyamide jacket

## APPENDIX D

NON-METALLIC SHEATH THICKNESS OF PREFERRED RANGE  
OF CABLES

(Normative)

TABLE D1

NON-METALLIC SHEATH THICKNESS OF PREFERRED RANGE  
OF CABLES

1	2	3	4	5
Nominal cross-sectional area of conductor  mm <sup>2</sup>	Non-metallic sheath thickness ( <i>t<sub>s</sub></i> ) mm			
	10-pair	30-pair	50-pair	100-pair
0.64	1.8	1.9	2.1	2.4
1.0	1.8	2.0	2.2	2.5
1.27	1.8	2.1	2.2	2.6
1.5	1.8	2.1	2.2	2.6

## APPENDIX E

## SUPPORT WIRE SIZE AND APPROXIMATE LINEAR MASS FOR PREFERRED RANGE OF CABLES

(Informative)

TABLE E1

## SUPPORT WIRE SIZE AND APPROXIMATE LINEAR MASS FOR PREFERRED RANGE OF CABLES

Nominal cross-sectional area of conductor  mm <sup>2</sup>	10-pair		30-pair		50-pair		100-pair	
	Mass per km kg	Support wire size mm						
0.64	689	7/1.60	1356	7/2.00	2094	7/2.75	3587	7/3.25
1.0	826	7/1.60	1714	7/2.00	2537	7/2.75	4684	7/3.25
1.27	864	7/1.60	1841	7/2.00	2851	7/2.75	5087	7/3.25
1.5	957	7/1.60	2108	7/2.00	3123	7/2.75	5890	7/3.25

The support wire in the table has been calculated on the following basis:

- (a) Span—80 m.
- (b) Wind speed—140 km/h.
- (c) Ambient temperature range —0°C to 45°C.
- (d) Sag—3.5 m at 45°C.
- (e) Minimum safety factor —3.

APPENDIX F  
GUIDE TO BENDING RADIUS OF NON-AERIAL CABLES  
(Informative)

**F1 METHOD**

The bending radius shall be taken as the radius measured to the cable surface on the inside of the bend.

**F2 MINIMUM BENDING RADIUS**

The minimum safe bending radius for installation of cables is shown in Table F1. In the case of cable constructions with a number of given features, the largest radius for those features shall be used.

**TABLE F1  
GUIDE TO MINIMUM BENDING RADIUS**

Cable construction		Recommended minimum internal bending radius	
		During installation	Installed
1	All cables without polyamide jackets	24D*	12D*
2	Polyamide jacketed cables	40D*	20D*

\* D is the cable overall diameter

APPENDIX G  
HIGH VOLTAGE TEST  
(Normative)

**G1 HIGH VOLTAGE TEST**

**G1.1 Test voltage**

The test shall be made using either alternating voltage of approximately sinusoidal waveform at power frequency or direct voltage at the manufacturer's option.

The test voltage shall be applied as follows—

- (a) between each conductor and all the remaining conductors (the conductors may be grouped together to reduce the number of tests); and
- (b) between all conductors bunched together and the screen.

**G1.2 Test method**

The voltage shall be raised gradually to the test value in a time not exceeding 1 min and shall be maintained for 1 min.

### **Standards Australia**

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

### **Standards New Zealand**

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

### **Australian/New Zealand Standards**

Under an Active Co-operation Agreement between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

### **International Involvement**

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

### **Visit our Web sites**

[www.standards.com.au](http://www.standards.com.au)

[www.standards.co.nz](http://www.standards.co.nz)



## Standards Australia

GPO Box 5420 Sydney NSW 2001

**Administration**

**Phone** (02) 8206 6000

**Fax** (02) 8206 6001

**Email** [mail@standards.com.au](mailto:mail@standards.com.au)

**Customer Service**

**Phone** 1300 65 46 46

**Fax** 1300 65 49 49

**Email** [sales@standards.com.au](mailto:sales@standards.com.au)

**Internet** [www.standards.com.au](http://www.standards.com.au)



**STANDARDS**  
NEW ZEALAND  
*Paerewa Aotearoa*

Level 10 Radio New Zealand House

155 The Terrace Wellington 6001

(Private Bag 2439 Wellington 6020)

**Phone** (04) 498 5990

**Fax** (04) 498 5994

**Customer Services** (04) 498 5991

**Information Service** (04) 498 5992

**Email** [snz@standards.co.nz](mailto:snz@standards.co.nz)

**Internet** [www.standards.co.nz](http://www.standards.co.nz)

This page has been left intentionally blank.