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(Incorporating Amendment No. 1)
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AS/NZS 5000.1:2005

Australian/New Zealand Standard™

Electric cables—Polymeric insulated

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

STANDARDS Australia

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

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 28 October 2005 and on behalf of the Council of Standards New Zealand on 4 November 2005.
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The following are represented on Committee EL-003:

Australasian Railway Association
Australian Electrical and Electronic Manufacturers Association
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Canterbury Manufacturers Association New Zealand
Department of Primary Industries, Mine Safety (NSW)
Electrical Contractors Association of New Zealand
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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

RECONFIRMATION

OF

AS/NZS 5000.1:2005
Electric cables—Polymeric insulated
Part 1: For working voltages up to and including 0.6/1 (1.2) kV

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.

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Electrical Compliance Testing Association
Electrical Regulatory Authorities Council
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NOTES

AS/NZS 5000.1:2005
(Incorporating Amendment No. 1)

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-003, Electric Wires and Cables to supersede AS/NZS 5000.1:2003.

This Standard incorporates Amendment No. 1 (December 2006). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide manufacturers and suppliers with construction details, dimensions and tests for cables and flexible cables insulated with thermoplastic, elastomer or XLPE materials intended for use in electrical installations at working voltages up to and including 0.6/1 (1.2) kV.

This Standard differs from the 2003 edition as follows:

(a) The method of specifying the thickness of insulation, separation layer, metallic sheath and oversheath has been aligned with IEC 60502-1.

(b) A 1.0 mm^2 earth core conductor size has been included.

(c) Optional aluminium wire armour has been included.

(d) The conductor resistance test has been specified as being carried out on completed cable to align with AS/NZS 1660.3.

(e) A legibility of marking test has been included.

(f) Requirements for qualification testing have been included.

In the preparation of this Standard, consideration was given to IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV),* Part 1: *Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)* and acknowledgment is made of the assistance received from that source.

The nominal cross-sectional areas of the conductors specified in this Standard are based on the values recommended in IEC 60228, *Conductors of insulated cables*.

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.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Electric cables—Polymeric insulated

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

1 SCOPE

This Standard specifies construction, dimensions and tests for single- and multicore cables insulated with polymeric materials intended for use in electrical installations at working voltages up to and including 0.6/1 (1.2) kV.

It does not apply to polymeric insulated cables for special installations and service conditions or for which there are separate Australian/New Zealand Standards, e.g. neutral screened cables, welding cables, flexible cords and aerial bundled cables.

NOTES:

1 Purchasing guidelines are contained in Appendix A.

2 AS/NZS 3008.1 should be referenced to assist correct cable size selection for the intended application and installation.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS
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
1660.2.2 Method 2.2: Insulation, extruded semi-conductive screens and non-metallic sheaths—Methods specific to elastomeric, XLPE and XLPVC materials
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1660.3 Method 3: Electrical tests
1660.5.6 Method 5.6: Fire tests—Test for vertical flame propagation for a single insulated wire or cable

2893 Electric cables—Lead and lead alloy sheaths—Composition

3000 Electrical installations

3008 Electrical installations—Selection of cables
3008.1 Part 1: Cables for alternating voltages up to and including 0.6/1 kV

3560 Electric cables—Cross-linked polyethylene insulated—Aerial bundled—For working voltages up to and including 0.6/1(1.2) kV (both Parts)

3808 Insulating and sheathing materials for electric cables

3863 Galvanized mild steel wire for armouring of cables

4507 Cables—Fire performance

4961 Electric cables—Polymeric insulated—For distribution and service applications

3 DEFINITIONS

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

3.1 Aerial cables

Cables used for applications where the cables are required to support their own weight when suspended unsupported in air.

3.2 Approximate value

A value which is neither guaranteed nor checked.

3.3 Core (of a cable)

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

3.4 Direction of lay

The slope of the helically laid-up cores, screen wire or armour wire, armour tape or the like, 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.

3.5 Fictitious values

Values calculated according to an equation that is based only on cross-sectional area of conductor, number of cores and specified component dimensions, and which ignores conductor shape, degree of compaction of conductors, and the possibility of components having dimensions other than specified (see Appendix B).

3.6 Fixed cable

A cable that is designed to be supported and fixed in position.

3.7 Flexible cable

A cable with conductors, insulation and covering that afford flexibility. The conductors of any cross-sectional area comprise a substantial number of wires of small diameter.

3.8 Multicore cable

A cable comprising two or more cores.

3.9 Nominal value

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

3.10 Non-hygroscopic material

A material that, after being pre-conditioned in an oven at 50 ±5°C for 24 ±1 h and allowed to cool in a desiccator, does not absorb more than 5 % by weight of moisture during a 48 h treatment in humidity of 95 ±4 % at a temperature of 20 ±5°C.

3.11 Pitch circle diameter

The diameter of a circle which passes through the mid-points of the laid-up cores of a layer.

3.12 Qualification test report

A report of results obtained from all routine, sample and type tests.

3.13 Routine tests

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

3.14 Sample tests

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

3.15 Shall

Indicates that a statement is mandatory.

3.16 Should

Indicates a recommendation.

3.17 Type tests

Tests made before supplying on a general commercial basis a type of cable covered by this Standard, to demonstrate satisfactory performance characteristics that meet the intended application.

3.18 Voltage designation

For cables for a.c. systems, the rated voltages U_0, U and U_m expressed in the form $U_0/U\,(U_m)$, 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.

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

U_m is the maximum r.m.s. power frequency voltage between any two phase 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 voltage variations due to fault conditions and sudden disconnection of large loads.

3.19 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 multicore cable, wire of a stranded conductor, screen or armour wire, screen or armour tape or the like.

4 VOLTAGE DESIGNATION

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

5 CONDUCTORS

Conductors shall comply with the relevant requirements of AS/NZS 1125. Where tinning is provided, any wires taken from the completed cable need not comply with the continuity test for tin plating specified in AS/NZS 1660.1.

Aluminium may be used for conductors of cross-sectional areas of 16 mm^2 and above.

For aerial cables the conductors shall be hard-drawn copper or aluminium.

A separator tape may be used over the conductor. Any such tape that does not adhere to the insulation shall be coloured or opaque.

6 INSULATION

6.1 Material

6.1.1 *General*

Insulation shall comply with the requirements of one of the following materials, in accordance with AS/NZS 3808:

Material groups	Designation
Cross-linked elastomeric materials	R-EP-90, R-E-110, R-CSP-90, R-CPE-90, R-S-150
PVC materials	V-75, V-90, V-90HT
Reduced fire hazard cable materials—	
Thermoplastic	HFI-75-TP, HFI-90-TP
Cross-linked	X-HF-90, X-HF-110, R-HF-90, R-HF-110
Polyolefin materials	X-90, X-90UV

6.1.2 *Aerial cables or fixed cables used in outdoor applications*

The insulation of unsheathed cables subjected to direct sunlight shall be a PVC material complying with the requirements of Clause 6.1.1 and containing a minimum of 1 % carbon black by weight.

NOTES:

1 A manufacturer's statement is sufficient evidence of conformance for PVC due to the unavailability of a suitable compliance test.

2 Aerial cables insulated with polyolefin materials are covered by AS/NZS 3560.

6.2 Application

The insulation shall be applied over, but shall not adhere to, the conductor.

For insulated, unsheathed multicore flat cables adjacent cores shall be connected by a web such that the cores can be easily separated by tearing without damage to the insulation of any core.

6.3 Thickness

The average thickness of insulation, excluding any separator tape, shall be not less than the nominal thickness (t_i) specified in Table 1, and the minimum thickness at any point shall not fall below the nominal thickness by more than 10 % of the nominal thickness plus 0.1 mm, i.e.

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

NOTE: The nominal thickness of insulation for 1.0 mm^2, 1.5 mm^2 and 2.5 mm^2 earth cores may be reduced, see Table 1, to match the size of active conductors with which they are commonly used.

TABLE 1
NOMINAL INSULATION THICKNESS

Nominal conductor cross-sectional area mm²	Nominal insulation thickness (t_i) mm				
	HFI-75-TP, HFI-90-TP, V-75, V-90, V-90HT	R-EP-90, R-E-110, R-CSP-90, R-CPE-90, R-HF-90 and R-HF-110		X-90, X-90UV X-HF-90 and X-HF-110	R-S-150
		Fixed	Flexible		
≤2.5	0.8	1.0	1.0	0.7	1.0
4	1.0	1.0	1.0	0.7	1.0
6	1.0	1.0	1.0	0.7	1.0
10	1.0	1.0	1.2	0.7	1.0
16	1.0	1.0	1.2	0.7	1.0
25	1.2	1.2	1.4	0.9	1.2
35	1.2	1.2	1.4	0.9	1.2
50	1.4	1.4	1.6	1.0	1.4
70	1.4	1.4	1.6	1.1	1.4
95	1.6	1.6	1.8	1.1	1.6
120	1.6	1.6	1.8	1.2	1.6
150	1.8	1.8	2.0	1.4	1.8
185	2.0	2.0	2.2	1.6	2.0
240	2.2	2.2	2.4	1.7	2.2
300	2.4	2.4	2.6	1.8	2.4
400	2.6	2.6	2.8	2.0	2.6
500	2.8	2.8	3.0	2.2	2.8
630	2.8	2.8	3.0	2.4	2.8
800	2.8	2.8	3.0	2.6	—
1000	3.0	3.0	—	2.8	—
1200	3.0	3.0	—	3.0	—
1.0 mm² earth core	0.6	0.8	—	0.5	0.8
1.5 mm² earth core	0.6	0.8	—	0.5	0.8
2.5 mm² earth core	0.7	0.9	—	0.6	0.9

6.4 Core identification

6.4.1 *Restricted colours*

The colours green and yellow, either alone or in combination with any other colour shall not be used except—

(a) when yellow printed characters identify cores by figures and words; or

(b) for earth cores as described in Clause 6.4.2.

6.4.2 *Method*

For other than unsheathed aerial cables, cores shall be clearly and durably identified by either colours or figures followed by words, in accordance with Clause 6.4.3 or Clause 6.4.4, as appropriate.

For unsheathed multicore flat cables, including aerial cables, either one of the cores of a 2-core cable and the centre core of a 3-core cable shall be identified for use as a neutral by at least 4 evenly spaced (approximately) longitudinal ribs.

For unsheathed multicore laid-up cables, including aerial cables, the phase cores shall be identified by surface colours or printing, and any neutral core shall be identified by the use of at least 4 evenly spaced (approximately) longitudinal ribs.

Earth cores shall be durably coloured and meet the requirements of AS/NZS 3000. Where a combination of green and yellow is used it shall be applied such that in any 15 mm length of core one of these colours covers at least 30 % and not more than 70 % of the surface of the core, and the other colour covers the remainder of the surface. The mass of the insulation shall be either green or yellow; the other colour may be part of the mass or a surface layer only. The green colour shall not fade to a phase colour.

For other than earth cores, the colouring for identification may be within the mass or at the surface of the core insulation or, where the core is further covered, the covering may be suitably coloured.

6.4.3 *Colours*

The recommended core colours for other than unsheathed aerial cables are as follows:

(a) *Phase cores* red, white (or uncoloured) and blue.

(b) *Neutral core* black.

(c) *Earth core* green/yellow.

6.4.4 *Figures and words*

Each figure shall be followed by the word that spells that figure (e.g. 1 ONE, 2 TWO, 3 THREE) in accordance with the following requirements:

(a) The numerals one (1), two (2), three (3), etc. shall be used to indicate active cores. If zero (0) is used, it shall indicate a neutral core.

(b) Minimum height, as follows:

Nominal conductor cross-sectional area mm^2	**Minimum height** mm
≤4	1.0
>4 ≤70	1.5
>70	3.0

(c) Where cores are identified by figures and words, the characters shall be printed in a colour contrasting with that of the core surface.

(d) Figures and words shall be spaced so that they are repeated at intervals of not greater than 100 mm.

7 ASSEMBLY OF CORES

7.1 Flat cables

For multicore cables the cores shall be laid parallel in the same plane.

7.2 Circular cables

7.2.1 *Lay-up of cores*

Cores, other than the centre core, shall be laid up in helical, helical 'SZ', or waveform configuration.

7.2.2 *Fillers, barrier tapes and binders*

When used, fillers, barrier/binder tapes and other binders shall be compatible with the other materials of the cable with which they are in contact.

Unless specified otherwise, the use of fillers, barrier/binder tapes and other binders is optional.

8 BEDDING (OPTIONAL)

8.1 General

Bedding complying with the requirements of this Clause or an oversheath complying with the requirements of Clause 13, shall be provided directly under any metallic layer.

Where dissimilar metallic layers are used, i.e. where electrolysis and galvanic corrosion is possible or electric potential differences may occur (e.g. one metallic layer is used as a neutral while other metallic layers are earthed), electrical separation is required. In this case bedding shall not be used and the metallic layers shall be separated by a separation layer complying with Clause 10.

8.2 Material

The bedding shall comprise non-metallic materials, either extruded or taped.

8.3 Application

8.3.1 *Taped bedding*

Taped bedding shall comprise one or more tapes applied to form a layer. For multicore cables with circular cores with a conductor size greater than 16 mm^2, fillers shall be used in the outer interstices.

8.3.2 *Extruded bedding*

Extruded bedding shall be applied over, but not adhere to the core assembly or underlying cable component. However, any binder or a barrier tape may adhere to the bedding. For multicore cables with circular cores with a conductor size greater than 16 mm^2, the outer interstices between the cores shall be filled by either fillers or the bedding.

8.4 Thickness

8.4.1 *General*

Except as provided for in Clause 8.4.2, the thickness of bedding shall be derived from Table 2.

8.4.2 *Reduced thickness taped bedding under a metallic screen or concentric conductor*

Where the metallic screen or concentric conductor to be applied over the core or core assembly comprises one or more metallic tapes of not greater than 0.08 mm nominal thickness, or wires not greater than 0.50 mm nominal diameter, the approximate thickness of the taped bedding may be reduced to 0.1 mm.

TABLE 2

APPROXIMATE THICKNESS OF BEDDING

Fictitious diameter under bedding (D_{uB}) (see Appendix B) mm		Approximate thickness of bedding mm	
		Extruded	Taped
	≤25	1.0	0.4
>25	≤35	1.2	0.4
>35	≤40	1.4	0.4
>40	≤45	1.4	0.6
>45	≤60	1.6	0.6
>60	≤80	1.8	0.6
>80		2.0	0.6

9 METALLIC LAYERS (OPTIONAL)

The metallic layer applied to single-core cable or the individual cores of a multicore cable shall be non-ferromagnetic, except where the cable is for d.c application only.

Multiple metallic layers may be applied over the core or core assembly in any order as appropriate for the intended use of the cable.

Unless otherwise specified (see Clauses 11 and 12) metallic layers shall be applied over a bedding complying with the requirements of Clause 8 or a separation layer complying with the requirements of Clause 10.

NOTES:

1 The following metallic layers may be used, as appropriate:

(a) Metallic screen, surrounding the cores either individually or collectively. Typically this may comprise, but is not restricted to, one or more metallic or metallized tapes, a wire braid or a concentric layer of wires helically applied or in waveform configuration, or a combination of metallic tape and wires.

(b) Concentric conductor (for cables other that those covered in AS/NZS 4961). Typically this may comprise, but not be restricted to, a concentric layer of wires helically applied or in waveform configuration.

(c) Metallic sheath (see Clause 12).

(d) Armour (see Clause 11).

2 For purchasing guidelines, see Appendix A.

10 SEPARATION LAYER (OPTIONAL)

10.1 General

Extruded separation layer(s) shall be applied when electrical or electrochemical separation between metallic layers is required (refer Clause 8.1).

10.2 Material and application

The separation layer shall comprise an appropriate material as specified in Clause 13.2, and shall be applied as specified in Clause 13.3.

10.3 Thickness

The nominal thickness of separation layer (T_s) shall be calculated from the following equation and rounded off to the nearest 0.1 mm, subject to a minimum value of 1.2 mm:

$$T_s = 0.02D_u + 0.60 \text{ mm}$$

where

D_u = fictitious diameter under the separation layer, in millimetres (see Appendix B)

The minimum thickness at any point of the separation layer shall not fall below the nominal thickness (T_s) by more than 20 % of the nominal thickness plus 0.20 mm, i.e.

minimum thickness = (0.80 T_s – 0.20 mm).

11 ARMOUR (OPTIONAL)

11.1 Material

Armour shall consist of galvanized low-carbon (mild) steel wires complying with AS/NZS 3863 or steel tape having a tensile strength in the range 300 to 450 MPa.

For non-ferromagnetic armour applications an aluminium wire armour may be used (see Clause 9).

11.2 Dimensions of wire and tape

The nominal diameter of the armour wire or the nominal thickness of the armour tape shall be not less than the appropriate values given in Tables 3 and 4, respectively.

11.3 Application

11.3.1 *General*

The armour shall be applied over an extruded bedding complying with the requirements of Clause 8, or over a separation layer complying with the requirements of Clause 10.

TABLE 3

DIAMETER OF ARMOUR WIRE

Fictitious diameter (D_B) (see Appendix B) mm		Nominal diameter of armour wire (t_A) mm
	≤10	0.8
>10	≤15	1.25
>15	≤25	1.6
>25	≤35	2.0
>35	≤60	2.5
>60		3.15

TABLE 4

THICKNESS OF ARMOUR TAPE

Fictitious diameter (D_B) (see Appendix B) mm		Nominal thickness of each tape* (t_A) mm
	≤30	0.2
>30	≤70	0.5
>70		0.8

* Subject to a tolerance of ±10 %

11.3.2 *Wire armour*

Wire armour shall be applied helically with minimal gap between adjacent wires.

Where double-wire armour is required, a separator comprising a layer of non-hygroscopic material of approximately 0.5 mm thickness shall be applied between the concentric layers of armour. For single-wire armour, or the inner layer of double-wire armour, the lay direction shall be opposite to the lay direction of helically laid-up cores, or left-hand over helical S-Z or waveform laid-up cores. The outer layer of double wire armour shall be in the opposite direction to the inner layer.

Joints in the armour wires shall be brazed or welded and any surface irregularities shall be removed.

11.3.3 *Tape armour*

Tape armour shall comprise steel tapes applied helically in two layers with the same direction of lay, so that the outer tape is centred approximately over the gap of the inner tape. The gap between adjacent turns of each tape shall not exceed 50 % of the width of the tape. The direction of lay shall be opposite to that of the cores in the case of helically laid-up cores, or left-hand in the case of helical S-Z or waveform laid-up cores. Joints in the tape shall be welded and surface irregularities removed.

11.4 Further protection

For a cable designed to be installed underground, armour shall be further protected by an oversheath in accordance with Clause 13.

12 METALLIC SHEATH (OPTIONAL)

12.1 Material

The metallic sheath shall be lead alloy E in accordance with AS/NZS 2893.

12.2 Application

The metallic sheath shall be removable without damage to the insulation or underlying core assembly. For single-core cables it may be applied directly over the core. For multicore cables, it shall be applied over an extruded bedding or separation layer.

12.3 Thickness

The nominal thickness of sheath (T_m) shall be calculated from the following equation and rounded off to the nearest 0.1 mm, subject to a minimum value of 1.0 mm:

$$T_m = 0.025\ D_{uM} + 0.700 \text{ mm}$$

where

D_{uM} = fictitious diameter under the metallic sheath, in millimetres (see Appendix B)

The minimum thickness at any point shall not fall below the nominal thickness (T_m) by more than 5 % of the nominal thickness plus 0.10 mm, i.e.

minimum thickness = ($0.95T_m - 0.10$ mm).

12.4 Further protection

For a cable designed to be installed underground, the metallic sheath shall be further protected by an oversheath in accordance with Clause 13.

13 OVERSHEATH (OPTIONAL)

13.1 General

In those cases where the oversheath is optional, it may be necessary to apply an oversheath in order to pass the vertical flame propagation test.

13.2 Material

To operate the conductor at the maximum temperature appropriate for the insulation, the temperature rating of the oversheath may be less than that of the insulation by not more than 5°C. For cables with R-S-150 insulation the maximum conductor temperature must be limited to be not higher than the maximum permitted for the selected oversheath material.

Any oversheath layer shall comply with the requirements of one of the following materials in accordance with AS/NZS 3808.

Material groups	Designation
Cross-linked elastomeric materials	GP-85-PCP, GP-90-CSP, GP-90-CPE, E-110-R
PVC materials	4V-75, 5V-90, V-90HT*
Reduced fire hazard cable materials	HFS-75-TP, HFS-90-TP, HFS-110-TP, HF-90-R, HF-110-R

* When used as an oversheath, the electrical characteristics tests and criteria do not apply

13.3 Application

The oversheath shall not adhere to the underlying cable component, except for any barrier tape or binder. The oversheath may fill the outer interstices.

13.4 Thickness

13.4.1 *Nominal thickness*

The nominal thickness of oversheath or combined layers of oversheath material (t_s) shall be calculated as follows:

(a) *Fixed cables (including flexible cables in fixed applications)*

The following equation shall be used:

$$t_s = 0.035\ D_p + 1.000 \text{ mm}$$

where

D_p = the fictitious diameter under oversheath, in millimetres (see Appendix B)

For flat cables the nominal thickness of the oversheath shall be calculated as if the cores were laid-up in circular configuration.

The calculated value of t_s shall be rounded off to one decimal place.

For unarmoured cables and cables with the oversheath not applied directly over the armour, metallic screen or concentric conductor, the nominal thickness shall be not less than 1.4 mm for single-core cables and 1.8 mm for multicore cables.

For cables with the oversheath applied directly over the armour, metallic screen or concentric conductor, the nominal thickness shall be not less than 1.8 mm.

NOTE: Refer to Appendix B for fictitious calculation of cable coverings.

(b) *Flexible cables*

(i) *Single-core*

The following equations shall be used:

(A) For single-core cables with conductors having cross-sectional areas up to and including 150 mm^2—

$$t_s = 0.125\ D_P + 1.000 \text{ mm}$$

(B) For single-core cables with conductors having cross-sectional areas exceeding 150 mm^2—

$$t_s = 0.05\ D_P + 2.40 \text{ mm}$$

(ii) *Multicore*

The following equations shall be used:

(A) For multicore cables with conductors having cross-sectional areas up to and including 6 mm^2—

$$t_s = 0.13\ D_P + 0.74 \text{ mm}$$

(B) For multicore cables with conductors having cross-sectional areas exceeding 6 mm^2—

$$t_s = 0.11\ D_P + 1.80 \text{ mm}$$

where

D_P = fictitious diameter under oversheath, in millimetres (see Appendix B)

The calculated value of t_s shall be rounded off to one decimal place.

13.4.2 *Minimum thickness at any point*

The minimum thickness at any point shall not fall below the nominal thickness (t_s) by more than one of the following:

(a) Unarmoured cables, cables with metallic or metallized tape screen or metal sheath and flexible cables: 15 % of the nominal thickness (t_s) plus 0.10 mm, i.e.

minimum thickness = (0.85 t_s – 0.10 mm).

(b) Armoured or wire screened cables or cables with concentric conductor where the oversheath is applied directly over the armour, screen or concentric conductor; 20 % of the nominal thickness (t_s) plus 0.20 mm, i.e.

minimum thickness = (0.80 t_s – 0.20 mm).

13.4.3 *Thickness of combined layer*

Where the oversheath consists of two layers of material, the nominal thickness of either layer shall be not less than 40 % of the calculated thickness, but in no case less than 1.0 mm. The minimum thickness at any point of the combined layer shall not fall below the calculated thickness by more than that specified in Clause 13.4.2.

For combined layers that can be separated then the minimum at any point of each layer shall not fall below the calculated value given by the equations in Clause 13.4.2, calculated for each layer and using the nominal thickness for that layer.

14 NON-METALLIC BRAID (OPTIONAL)

14.1 Material and application

The non-metallic braid shall comprise one of the following materials:

(a) Continuous filament glass fibre yarn of a quality suitable for electrical use.

(b) Polyethylene terephthalate fibre yarn.

It shall be closely and uniformly woven, fit snugly over the core or, where applied over the laid-up cores, the core assembly, and be impregnated with a suitable varnish. The varnish shall be applied so that it adheres to the braid to prevent ingress of moisture, sufficient to provide protection at the cable maximum operating temperature and under the degree of bending likely to be experienced during installation and use. The varnish shall also prevent fraying of the braid at terminations, and in the case of single-core cables, prevent braid slipping along the length of the cable.

14.2 Thickness

The approximate thickness of the braid, inclusive of the varnish coating, shall be in accordance with Table 5.

TABLE 5

APPROXIMATE THICKNESS OF NON-METALLIC BRAID

Fictitious diameter under braid		Approximate thickness of braid inclusive of the varnish coating	
		Glass	Polyethylene terephthalate
mm		mm	mm
	≤10	0.2	0.3
>10	≤20	0.3	0.5
>20	≤30	0.4	0.7
>30		0.5	0.9

15 PROTECTION FROM INSECT ATTACK (OPTIONAL)

Where protection from insect attack is required, an extruded jacket of polyamide 11 or 12, or copper, brass or stainless steel tapes helically applied, or other suitable means, may be incorporated in the cable construction.

When determined in accordance with AS/NZS 1660.2.1 for oversheath, the thickness of the polyamide shall be not less than 0.20 mm at any point and does not form part of the oversheath.

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

16 MARKING

16.1 Information to be marked

Cables shall be legibly and durably marked with the following information on the outermost surface, except as specified in Clause 16.2:

(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.

(d) The words 'ELECTRIC CABLE' and the voltage rating e.g. 0.6/1 kV.

A1 (e) Cables designed for specific applications shall be marked accordingly, as follows:

   (i) Aerial cables shall be marked with the word 'AERIAL'.

   (ii) Cables suitable for d.c. applications only shall be marked with the words 'FOR D.C. USE ONLY'.

   (iii) Fixed cables with flexible conductors shall be marked 'FOR FIXED APPLICATIONS ONLY'.

(f) Where cables have a phase conductor of nominal cross-sectional area greater than or equal to 16 mm^2 the conductor material and conductor nominal cross-sectional area is to be marked.

16.2 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) Alternative means of marking

For cables for which the outer surface does not facilitate marking, the marking shall consist of printing on a tape which is included throughout the length of the cable or printing, reproduction in relief (embossing) or stamping (indenting) of an inner component of the cable. The distance between the end of one block of marking and the beginning of the next shall not exceed 275 mm.

16.3 Legibility of marking on outer surface

The legibility of the marking shall be assessed with normal or corrected vision at an illuminance of 400-600 lux.

16.4 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) Standard number, including Part number, i.e. AS/NZS 5000.1.

(c) The voltage rating e.g. 0.6/1 kV.

(d) The number of cores and size of the conductor(s) and the conductor material.

(e) Designation of insulation and sheath.

(f) The catalogue number or type number or name or other marking to distinguish the cable including marking to identify any specific applications.

(g) Length of cable.

17 TESTS

17.1 General

Cables shall be tested in accordance with this Clause 17 and Table 6.

The category of test, criteria and reference for test method for cables manufactured to this Standard are given in Table 6 (see Clause 3 for definitions of 'type', 'routine' and 'sample' tests).

Type 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 or manufacturing process which might change the performance characteristics.

Cables that require specific performance characteristics shall comply with the additional requirements of the relevant Standard, e.g. reduced fire hazard cables shall comply with AS/NZS 4507.

17.2 Qualification test report

To supply cable on a commercial basis, the supplier shall, on request, make available a qualification test report (QTR) (see Clause 3.12) showing compliance with the tests in Table 6.

A QTR need not be prepared or submitted for each conductor size.

To qualify a particular type of cable over a range of conductor sizes, tests in Table 6 shall be carried out on a cable with a small and large conductor size in the range.

Such tests shall be deemed to qualify all sizes of cable from two sizes smaller than the smallest cable tested to two sizes larger than the largest size tested.

A QTR covering a multicore cable size will qualify a single-core cable of that size.

A separate QTR will be required for the following design changes:

(a) Different insulation designation.

(b) Different sheath designation.

TABLE 6

TESTS ON CABLE—PASS CRITERIA, CATEGORY AND REFERENCE

1	2	3	4	5
Test number	**Test**	**Pass criteria**	**Category of test**	**Reference for test method**
1	All tests, with the exception of conductor resistance and continuity for tin plating, on conductors taken from a completed cable	As specified in AS/NZS 1125 for the relevant conductor		
2	Conductor resistance on completed cable	As specified in AS/NZS 1125 for the relevant conductor	Sample	AS/NZS 1660.3
3	All tests on insulation taken from a completed cable (except for hot set test*)	As specified in AS/NZS 3808 for the relevant insulation designation		
4	All tests on oversheath and separation layer(s) taken from a completed cable	As specified in AS/NZS 3808 for the relevant material		
5	Measurement of insulation thickness	The average and minimum thicknesses of insulation shall comply with Clause 6	Sample*	AS/NZS 1660.2.1
6	Measurement of thickness of oversheath and separation layer(s)	The minimum thickness shall comply with Clause 10 or 13, as appropriate	Sample*	AS/NZS 1660.2.1
7	Measurement of thickness of polyamide jacket	The minimum thickness shall comply with Clause 15	Sample*	AS/NZS 1660.2.1
8	Measurement of armour dimensions	The dimensions shall comply with the requirements of Clause 11	Sample*	AS/NZS 1660.1
9	Measurement of metallic sheath thickness	The minimum thickness shall comply with the requirements of Clause 12	Sample*	AS/NZS 1660.1
10	High voltage a.c. test for 4 h	No breakdown	Type	AS/NZS 1660.3
11	Spark test on: (a) Insulated cores (b) Separation layer(s) (c) Sheath over metallic layer	No breakdown	Routine †	AS/NZS 1660.3
12	High voltage test for 5 min:			
	(a) Single-core cables without metallic layers		Not required	AS/NZS 1660.3
	(b) 2-, 3- or 4-core cables (not counting earth core) with conductors $\leq 35 mm^2$ insulated (unsheathed) or insulated and oversheathed (unscreened, unarmoured) construction	No breakdown	Sample*	AS/NZS 1660.3
	(c) All other cables not covered by (a) and (b) above	No breakdown	Routine	AS/NZS 1660.3
13	High voltage test for 5 min on separation layer(s)	No breakdown	Sample*	AS/NZS 1660.3

(*continued*)

TABLE 6 (*continued*)

1	2	3	4	5
Test number	**Test**	**Pass criteria**	**Category of test**	**Reference for test method**
14	Compatibility test after ageing in an air oven for insulation, separation layer (if any) and oversheath Duration—240 h Temperature— For rated insulation temperature of— (a) 75°C, test at 85±2°C; (b) 90°C, test at 100±2°C; or (c) 110°C, test at 120±2°C. 1) Tensile strength, minimum, for each material (percentage of value found in the unaged specimen) 2) Elongation at rupture, minimum for each material (percentage of value found in the unaged specimen)	 75 65	Type	AS/NZS 1660.2.2 or AS/NZS 1660.2.3 as appropriate
15	Vertical flame propagation (see Notes 1 and 2)	The distance between the lower edge of the top support and the onset of charring shall be greater than 50 mm. The charring shall not extend downwards to a point greater than 540 mm from the lower edge of the top support. During the test, any falling particles shall not ignite the filter paper underlay.	Type	AS/NZS 1660.5.6
16	Legibility of marking on outer surface	The marking shall be legible.	Type	Clause 16.3

*These tests may be conducted during production or on completed cable.
†This test is carried out on the full length of cable during production

NOTES:

1 *Application to assessment of fire hazard* The test provides direct data on the likelihood of a single electric cable igniting and transmitting fire when exposed to a specified external ignition source. Fire, however, is a complex phenomenon and its behaviour, when 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 possible fire conditions. There must be a constant awareness of these interrelated factors and 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.

2 *Cautionary note* When reporting the results, the following cautionary note should 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 as 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 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 5000.1.

(b) Length of cable required and individual drum lengths if required.

(c) Number of active cores.

(d) Earth core, if requested.

(e) Conductor size, i.e. nominal cross-sectional area.

(f) Designation of insulation, e.g. V-75, HFI-75-TP.

(g) Details of screen, if required.

(h) Whether metallic sheath is required.

(i) Type of armour, if required.

(j) Designation and colour of oversheath.

(k) Whether protection from insect attack is required.

(l) Whether metre marking is required.

(m) Whether non-metallic braid is required.

APPENDIX B

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

(Normative)

B1 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 makeup 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, thicknesses being precalculated and specified for each size of cable.

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

B2 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 Appendix C.

Binder tapes are ignored in this calculation method.

B3 METHOD

B3.1 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 B1.

TABLE B1

FICTITIOUS DIAMETER OF CONDUCTOR

Nominal cross-sectional area of conductor mm^2	Fictitious diameter (d_L) mm	Nominal cross-sectional area of conductor mm^2	Fictitious diameter (d_L) mm
0.5	0.8	185	15.3
1.0	1.1	240	17.5
1.5	1.4	300	19.5
2.5	1.8	380	22.0
4	2.3	400	22.6
6	2.8	480	24.7
10	3.6	500	25.2
16	4.5	600	27.6
25	5.6	630	28.3
35	6.7	740	30.7
50	8.0	800	31.9
70	9.4	960	35.0
95	11.0	1 000	35.7
120	12.4	1 200	39.1
150	13.8		

B3.2 Cores

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

$$D_c = d_L + 2t_i \qquad \text{. . . B3.2}$$

where

t_i = the nominal insulation thickness as specified in Table 1

If a metallic screen or a concentric conductor is applied, a further addition shall be made in accordance with Paragraph B3.5.

B3.3 Diameter over laid-up cores

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

(a) For cables comprising cores with all conductors of the same nominal cross-sectional area—

$$D_f = kD_c \qquad \text{. . . B3.3(1)}$$

where

k = the coefficient given in Table B2 corresponding to the number of cores in the cable

(b) For cables comprising cores with conductors of differing nominal cross-sectional area, the greater of the two values calculated from the following equations:

$$D_f = kD_{ca} \qquad \text{. . . B3.3(2)}$$

where

k = the coefficient given in Table B2 corresponding to the total number of cores in the cable

D_{ca} = the calculated average fictitious core diameter (including any metallic screen, etc. applied on each core)

See Examples 1 and 2.

$$D_f = kD_{c1} \quad \text{. . . B3.3(3)}$$

where

k = the coefficient given in Table B2 corresponding to the number of full size (main) cores in cable

D_{c1} = fictitious diameter of the full size (main) cores (including any metallic screen or covering applied on each core)

Example 1

For a 4-core cable with one insulated conductor of reduced nominal cross-sectional area—

$$D_{ca} = \frac{3D_{c1} + D_{c2}}{4}$$

where

D_{c1} = fictitious diameter of the full size (main) cores

D_{c2} = fictitious diameter of the reduced size core

Example 2

For a 5-core cable with two insulated conductors of reduced nominal cross-sectional area, e.g. a reduced size neutral and a reduced size earth—

$$D_{ca} = \frac{3D_{c1} + D_{c2} + D_{c3}}{5}$$

where

D_{c1} = fictitious diameter of the full size (main) cores

D_{c2} = fictitious diameter of the neutral core

D_{c3} = fictitious diameter of the earth core

TABLE B2

FICTITIOUS LAY-UP DIAMETER COEFFICIENT FOR MULTICORE CABLES

Number of cores	Lay-up diameter coefficient (*k*)	Number of cores	Lay-up diameter coefficient (*k*)	Number of cores	Lay-up diameter coefficient (*k*)
2	2.00	18	5.00	38	7.33
3	2.16	18*	7.00	39	7.33
4	2.42	19	5.00	40	7.33
5	2.70	20	5.33	41	7.67
6	3.00	21	5.33	42	7.67
7	3.00	22	5.67	43	7.67
7*	3.45	23	5.67	44	8.00
8	3.45	24	6.00	45	8.00
8*	3.66	25	6.00	46	8.00
9	3.80	26	6.00	47	8.00
9*	4.00	27	6.15	48	8.15
10	4.00	28	6.41	49	8.15
10*	4.40	29	6.41	50	8.15
11	4.00	30	6.41	51	8.41
12	4.16	31	6.70	52	8.41
12*	5.00	32	6.70	53 to 57	8.70
13	4.41	33	6.70	58 to 61	9.00
14	4.41	34	7.00		
15	4.70	35	7.00		
16	4.70	36	7.00		
17	5.00	37	7.00		

* Cores assembled in one layer.

B3.4 Bedding

The fictitious diameter over the bedding (D_B) is equivalent to the fictitious diameter under any metallic layer and is given by the following equation:

For a bedding complying with Clause 8 or for a sheath under armour complying with Clause 13—

$$D_B = D_{uB} + 2t_B \quad \text{. . . B3.4}$$

where

D_{uB} = D_f, for bedding over laid-up cores

= D_c, for bedding over single cores

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

= 0.6 mm for D_{uB} exceeding 40 mm

Except for flexible cables, these fictitious values for t_B apply to all multicore cables whether or not a bedding is applied and whether the bedding, if any, is extruded or lapped, unless a separation layer (complying with Clause 10) is used in place of or in addition to the bedding when Paragraph B3.7 applies instead.

For flexible cables the value t_B for bedding is not taken into account.

B3.5 Metallic screen or concentric conductor

The increase in diameter (y) due to the metallic screen or concentric conductor is given in Table B3.

TABLE B3

INCREASE IN FICTITIOUS DIAMETER OF A CABLE COMPONENT DUE TO METALLIC SCREEN OR CONCENTRIC CONDUCTOR

Cross-sectional area* of metallic screen or concentric conductor mm²		Increase in diameter (y) mm	Cross-sectional area* of metallic screen or concentric conductor mm²		Increase in diameter (y) mm
	≤4	0.5	>50	≤70	2.0
>4	≤6	0.6	>70	≤95	2.4
>6	≤10	0.8	>95	≤120	2.7
>10	≤16	1.1	>120	≤150	3.0
>16	≤25	1.2	>150	≤185	4.0
>25	≤35	1.4	>185	≤240	5.0
>35	≤50	1.7	>240		6.0

* For the purpose of the fictitious calculation the gross cross-sectional area applies, i.e. the 'lay loss' due to the application of the screen or concentric conductor (e.g. due to the helix of screen wire) is ignored.

B3.6 Metallic sheath

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

$$D_m = D_{uM} + 2T_m \qquad \text{. . . B3.6}$$

where

D_{uM} = the fictitious diameter under the metallic sheath

T_m = the nominal thickness of the metallic sheath, calculated by the method given in Clause 12.3

B3.7 Separation layer

(For example, separation of the copper screen from the galvanized steel wire armour)

The fictitious diameter over the separation layer (D_s) is given by—

$$D_s = D_u + 2T_s \qquad \text{. . . B3.7}$$

where

D_u = the fictitious diameter under the separation layer

T_s = the nominal thickness of the separation layer, calculated by the method given in Clause 10

B3.8 Armour

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

(a) Wire armour

$$D_x = D_B + 2t_A \qquad \text{. . . B3.8(1)}$$

where

D_B = the fictitious diameter under the armour

t_A = the nominal diameter of the armour wire

(b) Tape armour

$$D_x = D_B + 4t_A \qquad \text{. . . B3.8(2)}$$

where

D_B = the fictitious diameter under the armour

t_A = the nominal thickness of the armour tape

B3.9 Oversheath

The fictitious diameter under the oversheath (D_P) is given by one of the following:

D_P = D_x, for armoured cables

= D_c, for single core cables

= D_f, for laid-up, oversheathed cables

= D_m, for metallic sheathed cables

APPENDIX C

ROUNDING OF NUMBERS

(Normative)

C1 ROUNDING OF NUMBERS IN THE 'FICTITIOUS CALCULATION METHOD'

The rules set out in this Appendix shall apply when rounding numbers in calculating fictitious diameters and determining dimensions of component layers in accordance with Paragraph B3, Appendix B.

When the calculated value at any stage has more than one decimal place, the value shall be rounded to one decimal place, i.e. to the nearest 0.1 mm. The fictitious diameter at each stage shall be rounded to 0.1 mm and, when used to determine the thickness or dimension of an overlying layer, it shall be rounded before being used in the appropriate equation or table. The thickness calculated from the rounded value of fictitious diameter shall in turn be rounded to 0.1 mm, as required in Paragraph B2, Appendix B.

To illustrate these rules, the following practical examples are given:

(a) When the figure in the second decimal place before rounding is 0, 1, 2, 3 or 4, then the figure retained in the first decimal place remains unchanged (rounding down).

Examples:	2.12	~	2.1
	2.449	~	2.4
	25.0478	~	25.0

(b) When the figure in the second decimal place before rounding is 9, 8, 7, 6 or 5, then the figure in the first decimal place is increased by one (rounding up).

Examples:	2.17	~	2.2
	2.453	~	2.5
	30.050	~	30.1

C2 ROUNDING OF NUMBERS FOR OTHER PURPOSES

For purposes other than those set out in Paragraph C1, values may have to be rounded to more than one decimal place. This may occur, for example, when calculating the average value of several measurement results, or the minimum value by applying a percentage tolerance to a given nominal value. In such cases, rounding shall be carried out to the number of decimal places specified in the relevant clauses.

The method of rounding shall then be as follows:

(b) If the last figure to be retained is followed, before rounding, by 0, 1, 2, 3 or 4, it shall remain unchanged (rounding down).

(c) If the last figure to be retained is followed, before rounding, by 9, 8, 7, 6 or 5, it shall be increased by 1 (rounding up).

Examples:	2.449	~	2.45	Rounded to two decimal places
	2.449	~	2.4	Rounded to one decimal place
	25.0478	~	25.048	Rounded to three decimal places
	25.0478	~	25.05	Rounded to two decimal places
	25.0478	~	25.0	Rounded to one decimal place

AMENDMENT CONTROL SHEET

AS/NZS 5000.1:2005

Amendment No. 1 (2006)

REVISED TEXT

SUMMARY: This Amendment applies to Clause 16.1.

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NOTES

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