

Australian/New Zealand Standard™

**Electrical installations—Classification of
the fire and mechanical performance of
wiring system elements**



AS/NZS 3013:2005

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-037, Special Wiring Systems. It was approved on behalf of the Council of Standards Australia on 13 July 2005 and on behalf of the Council of Standards New Zealand on 29 July 2005. This Standard was published on 22 August 2005.

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Australian Chamber of Commerce and Industry
Australian Electrical and Electronic Manufacturers Association
Australian Industry Group
CSIRO Manufacturing & Infrastructure Technology
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Australian/New Zealand Standard™

**Electrical installations—Classification of
the fire and mechanical performance of
wiring system elements**

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PREFACE

This Standard was prepared by the Standards Australia/Standards New Zealand Committee EL-037 on Special Wiring Systems to supersede [AS/NZS 3013:1995](#), *Electrical installations—Classification of the fire and mechanical performance of wiring systems* one year from publication. During this period, it is anticipated that regulatory authorities and others will accept wiring systems to either publication.

This Standard will be referenced in the Building Code of Australia by way of BCA Amendment thereby superseding [AS/NZS 3013:1995](#) which will be withdrawn 12 months from the date of publication of this Standard.

This revision was undertaken to make the following changes to the testing regime:

- (a) Allow individually tested elements to be combined to construct a wiring system. This removes the situation in the previous edition whereby it was inferred that the total system must be tested, and that installations must be configured as tested. Previously the onus of testing had fallen on cable companies and the contractor had to make a judgement as to the effect on installations that have deviated from the ‘as tested’ wiring system.
- (b) Define a test installation that is more repeatable between tests and test houses, and that is more representative of installation practice. This is a result of the extensive testing conducted since the introduction of the first edition in 1990.
- (c) Define the cables to be tested so that they are more representative of those most commonly used.
- (d) Remove ambiguity regarding different cable types.

The need to maintain circuit integrity in buildings, oil rigs, ships, and other structures under fire conditions may be required by regulations and codes for wiring systems associated with firefighting, evacuation, emergency equipment, essential services and other safety functions.

While there are some Standards available for fire testing of cables (e.g. [IEC 60331](#), *Fire-resisting characteristics of electric cables*; [IEC 60332](#), *Tests on electric cables under fire conditions*; and [BS 6387](#), *Specification for performance requirements for cables required to maintain circuit integrity under fire conditions*), it was considered that these did not form an adequate basis for a system of classification. For this reason, [AS 1530.4](#), *Fire-resistance test of elements of building construction* has been used as the basis of fire protection classification of wiring system elements in this Standard. Testing in a horizontal furnace has been prescribed since it was considered that this represents the most onerous condition.

This Standard provides a system of classification of the degree of protection inherent in wiring system elements against accidental mechanical damage. It does not consider protection against deliberate tampering. The levels of mechanical protection are specified in terms of impact energies and cutting forces.

Appendices designated as ‘normative’ are essential to the understanding or implementation of this Standard. Appendices designated as ‘informative’ give additional information, recommendations, guidelines or other non-mandatory statements.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electrical installations—Classification of the fire and mechanical performance of wiring system elements**

SECTION 1 SCOPE AND APPLICATION

1.1 SCOPE

This Standard sets out a classification system for wiring system elements. The classification is according to the wiring system's ability to—

- (a) maintain circuit integrity under fire conditions for a specified period; and
- (b) maintain circuit integrity against mechanical damage of specified severity.

It specifies type tests to classify the performance of the various types of wiring system elements.

If an assembled wiring system is tested to this Standard, the classification achieved cannot be assigned to any one of its individual elements. The wiring system classification achieved shall only be applicable to the assembled wiring system as tested.

This Standard does not address the screening function of screened cables after exposure to fire conditions.

NOTE: Elements of a wiring system might need replacement after exposure to fire conditions or mechanical damage.

1.2 APPLICATION

This Standard is referenced in the Building Code of Australia.

This Standard applies only to the testing and classification of wiring systems elements that are in all other respects safe and suitable for their intended use and comply with other relevant Standards.

A wiring system is then assembled using the individual elements and a fire and mechanical performance classification for the assembled system is established.

The fire protection classification of a wiring system shall not be greater than the fire protection classification of its lowest classified element.

The mechanical protection classification of an assembled wiring system shall not be less than the mechanical protection classification of its highest classified element. For example, if a cable of low classification is protected by an enclosure of higher classification the assembled system is assigned the classification of the enclosure.

The use of wiring system elements tested in accordance with this Standard may not be necessary where parts (or components) of building construction provide satisfactory protection against fire conditions and mechanical damage.

NOTE: The degree of protection against fire conditions and mechanical damage required of a wiring system or its elements is dependent on the application. Appendix F describes methods of protection of wiring system elements against the fire conditions and mechanical damage for which testing may not be considered necessary.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- 1074 Steel tubes and tubulars for ordinary service
 1530 Methods for fire tests on building materials, components and structures
 1530.4 Part 4: Fire-resistance tests of elements of building construction

AS/NZS

- 1125 Conductors in insulated electric cables and flexible cords
 2053 Conduits and fittings for electrical installations (all parts)
 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
 3187 Approval and test specification—Mineral-insulated metal-sheathed cables
 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 (1.2) kV

1.4 DEFINITIONS

For the purpose of this Standard the definitions given in [AS/NZS 3000](#) and those below apply:

1.4.1 Busway

A wiring system comprising rigid conductors spaced apart, rigidly supported on insulating material within a duct, trunk or similar enclosure.

1.4.2 Cable

A single core, or two or more cables cores laid up together, either with or without fillings, reinforcements, or protective coverings.

1.4.3 Cable core

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

1.4.4 Cable, mineral insulated metal sheathed (MIMS)

A cable having compressed powdered mineral insulation enclosed in metal sheathing. Such cable may be either single-core or multicore. Such cable may be bare sheath or PVC served.

1.4.5 Circuit integrity

The ability of an electrical circuit to perform the function for which it has been designed.

1.4.6 Element of a wiring system

A part or component of the wiring system.

1.4.7 Enclosed wiring system

A wiring system protected by means of an enclosure against fire conditions and mechanical damage.

1.4.8 Enclosure

A part providing protection against fire conditions and mechanical damage and against contact with live parts.

1.4.9 Fixings

Devices such as screws, bolts and anchors used to fix supports to a building or other structure.

1.4.10 Saddles

Supports which are intended for use with a cable or conduit.

1.4.11 Sample

A representative part taken from a product for testing purposes.

1.4.12 Shall

Indicates that a statement is mandatory.

1.4.13 Test specimen

Example: A part of a sample to which a test is applied for the Fire Test for Group 1 cables, the sample is the '35 mm² single core cable (manufacturers part number}'. The specimen is any one of the three cables required for the test.

1.4.14 Submitter

An organization or individual that submits a sample cable, busway, wiring enclosure support or fixing to a testing authority for testing in accordance with this Standard.

1.4.15 Supports

Items, such as saddles, cable trays, cable ladders, brackets and cable ties, used to support wiring enclosures, cables or busways.

1.4.16 Unenclosed wiring system

A wiring system directly exposed to fire conditions or mechanical damage.

1.4.17 Wiring enclosure

A pipe, tube, duct, conduit or cable trucking, fixed or supported in position for the housing or protection of sheathed or unsheathed cables.

1.4.18 Wiring system

An arrangement of cables, busways, supports, fixings and enclosures, all of which are part of the wiring system.

1.4.19 Live part

A conductor or conductive part intended to be energized in normal use, including a neutral conductor and conductive parts connected to a neutral conductor.

Notwithstanding the above, for the purpose of this Standard, the following are not considered live parts:

- (a) Earthing conductors.
- (b) The MEN connection and the neutral bar or link at which the MEN connection is made.
- (c) The sheath of an MIMS cable and associated conductive fittings used as a combined neutral and protective earthing conductor in an ESR system.
- (d) Conductive supports and enclosures associated with unprotected consumer mains which are earthed in accordance with [AS/NZS 3000](#).

SECTION 2 TESTING OF WIRING SYSTEM ELEMENTS

For wiring system elements to use the classification system provided in this Standard, the elements shall have been tested and have passed the tests detailed in the following Appendices:

- (a) Appendix A Fire test method—Cables and busways.
- (b) Appendix B Water test method —Cables and busways.
- (c) Appendix C Fire test method—Supports and fixings.

A cable tray ladder of greater engineered strength may be substituted for a lighter section than that tested in accordance with Appendix C, provided the originally tested loads are not exceeded and that the design and construction characteristics are identical.

Supports and fixings are deemed to be suitable for use with cables or busways if the calculated load for the cables or busways is equal to or less than the load used in the test.

- (d) Appendix D Mechanical test method—Impact test—Cables, busways and enclosures.
- (e) Appendix E Mechanical test method—Cutting test—Cables and enclosures.
- (f) Appendix F Applications guide.

This Standard does not provide for mechanical testing of fixings or supports.

SECTION 3 CLASSIFICATION SYSTEM

3.1 DESIGNATION

3.1.1 General

The basic designation used to indicate the ability of the elements of a wiring system to maintain circuit integrity under fire conditions for a specified period and to maintain circuit integrity against mechanical damage of specified severity shall consist of a code of four characters.

3.1.2 Basic designation

The designation shall consist of the following characters—

- (a) the characteristic letters 'WS' (wiring system);
- (b) followed by a first characteristic numeral, where applicable (see Clause 3.2);
- (c) followed by a second characteristic numeral, where applicable (see Clause 3.3); and
- (d) a supplementary letter 'W' which may be added, where applicable (see Clause 3.4.).

3.1.3 Single characteristic numeral designation

Where an element classification is indicated by only one characteristic numeral, the letter 'X' shall be used in the position normally occupied by the omitted characteristic numeral, e.g. WSX5 or WS2X.

3.2 FIRST CHARACTERISTIC NUMERAL

3.2.1 Purpose

The first characteristic numeral represents the time for which cables and busways are able to maintain circuit integrity under specified fire conditions. It also represents the time that the supports and fixings are able to support their nominated load under specified fire conditions.

3.2.2 Ability to maintain circuit integrity

When tested in accordance with Appendix A, cables and busways shall maintain circuit integrity for the minimum time specified in Table 3.1 in order to be assigned the associated characteristic numeral.

3.2.3 Compliance

Compliance of a wiring system element with a stated degree of fire protection means that the element also complies with degrees of protection of lower rank in Table 3.1, i.e. of a lower numeral, and therefore tests for degrees of protection of lower rank need not be conducted.

TABLE 3.1
DEGREE OF PROTECTION INDICATED
BY THE FIRST CHARACTERISTIC NUMERAL
(Protection against fire conditions)

First characteristic numeral	Minimum time for which the test is conducted min
1	15
2	30
3	60
4	90
5	120

3.3 SECOND CHARACTERISTIC NUMERAL

3.3.1 Purpose

The second characteristic numeral represents the degree of mechanical impact and cutting force to which an element of a wiring system can be subjected to the criteria specified without failure.

3.3.2 Test conditions

Table 3.2, columns 2 and 3 give details of the minimum impact energies and cutting force criteria for the wiring system element.

3.3.3 Compliance

Compliance of an element of a wiring system with a stated degree of mechanical protection means that the element of a wiring system also complies with degrees of protection of lower rank in Table 3.2, i.e. of lower numeral, and therefore tests for degrees of protection of lower rank need not be conducted.

3.3.4 Classification

Impact and cutting tests shall be performed and the results recorded. The wiring system element classification is taken to be the lowest of the two results.

The cutting test (Appendix E), is not a classification criteria for busways. The mechanical classification for busway systems is determined from the impact test (Appendix D) alone.

TABLE 3.2
DEGREES OF PROTECTION INDICATED BY THE
SECOND CHARACTERISTIC NUMERAL
(Protection against mechanical damage)

1	2	3	4
Second characteristic numeral	Test criteria		Level of impact protection
	Impact test (Appendix D) J	Cutting test (Appendix E) kN	
1	2.5	0.3	light
2	15	1.0	moderate
3	50	5.0	heavy
4	500	5.0	very heavy
5	5 000	5.0	extremely heavy

NOTE: Appendix F provides guidance on the use of the classification system.

3.4 SUPPLEMENTARY LETTER W

3.4.1 Purpose

The supplementary letter W, when added to the basic designation, represents the ability of cables and busways to maintain circuit integrity when subject to the fire test in accordance with Appendix A, followed by a water spray test in accordance with Appendix B.

3.4.2 Ability to maintain circuit integrity

The addition of the supplementary letter W to a cable or busway classification means that the cable or busway is able to maintain circuit integrity when—

- (a) tested against exposure to fire conditions in accordance with Appendix A for the period specified by the first characteristic numeral (see Clause 3.2); and
- (b) then subjected to a water spray test, as specified in Appendix B.

3.4.3 Compliance

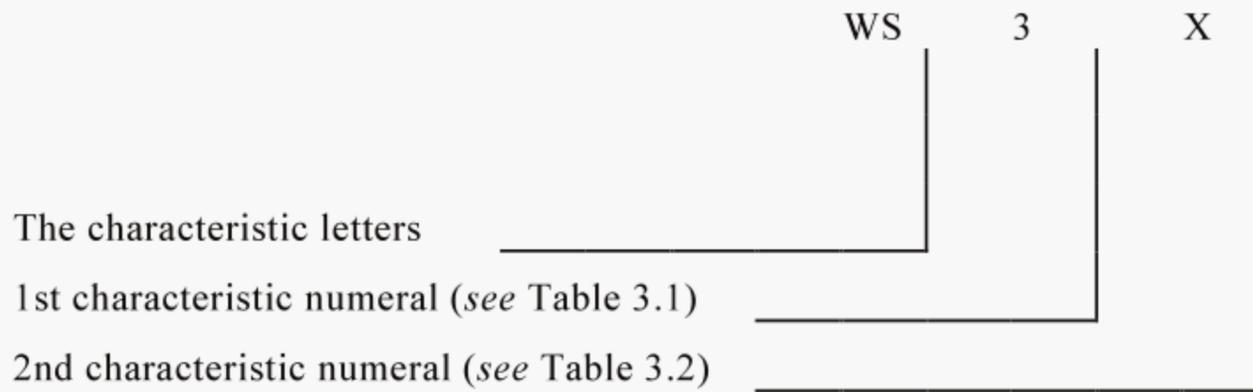
Compliance of an element of a wiring system to a 'W' classification means that the element is able to maintain circuit integrity in accordance with Clause 3.4.2. Tests for first characteristic numeral of lower rank classification need not be conducted.

The water spray test need not be performed on supports and fixings. Supports and fixings are deemed to comply and may be assigned a supplementary letter 'W' in their classification.

3.5 EXAMPLES OF CLASSIFICATIONS

Example 1:

Cables or busways, which maintain circuit integrity for 60 min when tested in accordance with Appendix A, would be designated WS3X, where the symbols are represented as follows:



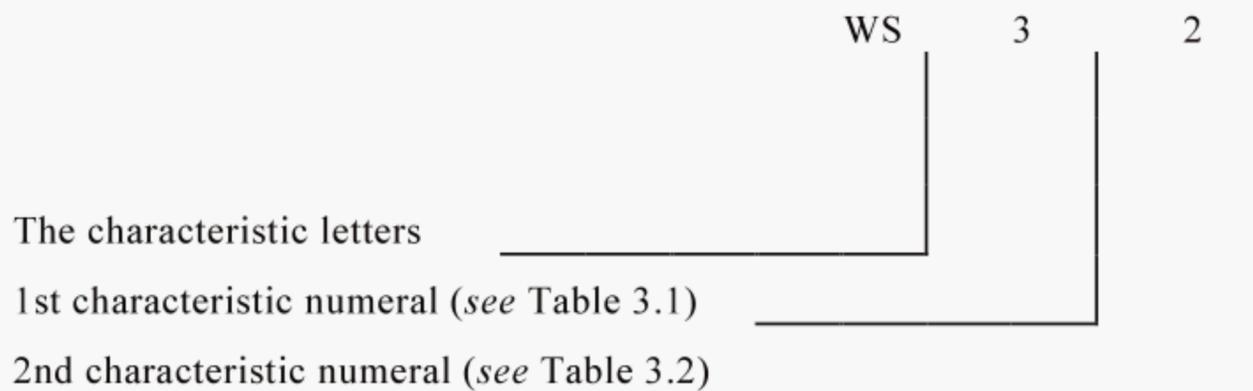
(X denotes that the second characteristic numeral has not been assessed)

Example 2:

Cables or busways which—

- (a) maintain circuit integrity for 60 min when tested in accordance with Appendix A; and
- (b) maintain circuit integrity when subject to the impact energies and cutting force criteria of Table 3.2 and tested in accordance with Appendix D and E for cables, and Appendix D only for busways.

would be designated WS32, where the symbols represent:

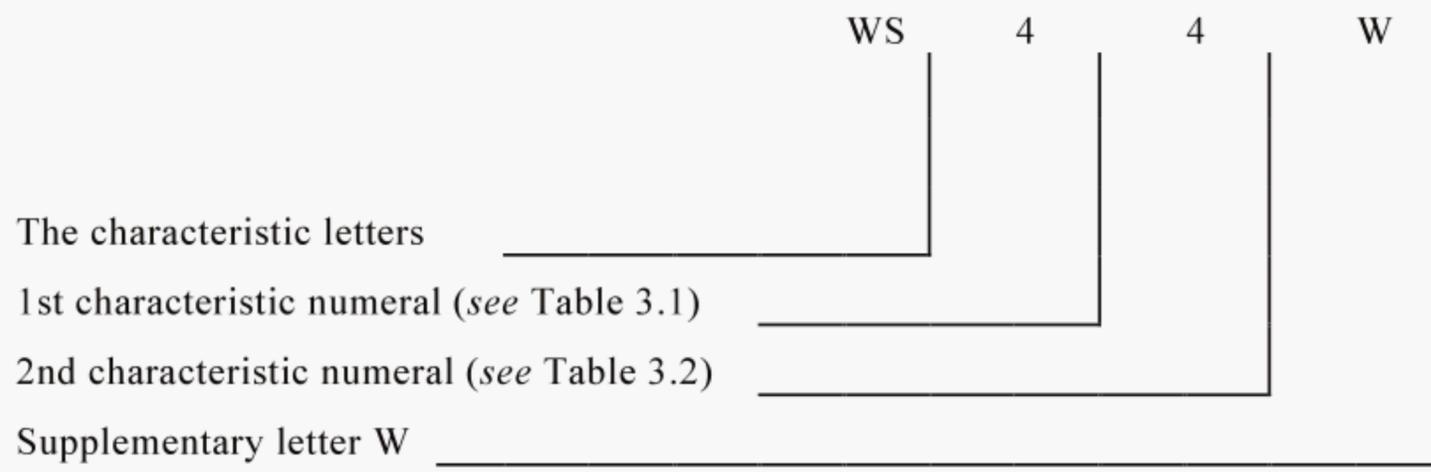


Example 3:

Cables or busways which—

- (a) maintain circuit integrity for 90 min when tested in accordance with Appendix A; and
- (b) continue to maintain circuit integrity when the test in accordance with Appendix A is followed by the water spray test in accordance with Appendix B; and
- (c) maintain circuit integrity when subject to the impact energies and cutting force criteria of Table 3.2 and tested in accordance with Appendix D and E for cables, and Appendix D only for busways.

would be designated WS44W, where the symbols represent:



APPENDIX A
FIRE TEST METHOD—CABLES AND BUSWAYS
(Normative)

A1 SCOPE

This Appendix sets out a test method that is used to assess the ability of cables and busways to maintain circuit integrity under fire conditions.

A2 APPLICATION

This method applies to unenclosed cables and busways.

While the test is performed utilizing a common installation configuration, the successful completion of this test qualifies the cables and busways for all unenclosed installation methods of the respective cables or busways.

A3 PRINCIPLE

Specimens of a cable or busway are placed in a furnace, which is programmed to follow a standard time–temperature curve, in order to determine the ability of cables or busways to maintain circuit integrity under fire conditions.

A4 TEST SPECIMENS

A4.1 General

Test specimens shall include all elements for which classification is sought including any joints or components forming part of the wiring system.

A4.2 Cables

A4.2.1 *Groups for qualification*

Cable types shall be divided into the following groups, based on the cable construction:

Group 1	Single-core for use as live conductors
Group 2	Multicore with or without earth, cross-sectional area greater than 6 mm ²
Group 3	Multicore with earth, cross-sectional area equal to or less than 6mm ²
Group 4	Multicore without earth, cross-sectional area equal to or less than 6 mm ²
Group 5	Single-core mineral insulated metal sheathed (MIMS)
Group 6	Multicore mineral insulated metal sheathed (MIMS)

NOTE: Earthing conductors intended for use with single-core cables need not be tested.

The requirements for each group are as follows:

- (a) For qualification of Group 1, the specimens to be tested shall be three single-core 35 mm² cables arranged in a trefoil configuration. This shall qualify all other single core sizes, with the following exceptions:
 - (i) Tests on any other size of cable specifically qualify that size only.

- (ii) Changes in the class of conductor (as defined in [AS/NZS 1125](#)) require a separate qualification using 35 mm² cables in the trefoil configuration.
 - (iii) Changes in the flame/fire barrier (i.e. material type or construction, yield, coverage or number of tapes applied) require a separate qualification using 35 mm² cables in the trefoil configuration.
 - (iv) Screened, braided or armoured single cores constitute a different cable construction and therefore require a separate qualification using 35 mm² cables in the trefoil configuration. Any metallic covering shall be earthed during the tests.
 - (v) Changes in cable voltage rating require a separate qualification using 35 mm² cables in a trefoil configuration.
 - (vi) A cable having a different insulation or sheath designation shall be classed as a different 'type of cable' and shall require a separate qualification. The designation of insulation and designation of sheath is as defined in [AS/NZS 3808](#) and a different 'type of cable' is when a different material (as defined in [AS/NZS 3808](#)) is used.
- (b) For qualification of Group 2, the specimen to be tested shall be a single 10 mm² three-core and earth sheathed circular cable. This test shall qualify all other multicore cable sizes, and qualifies the range of constructions such as the 2C, 2C+E, 3C, 3C+E, 4C, and 4C+E, with the following exceptions:
- (i) Tests on any other size of cable specifically qualify that size only.
 - (ii) Changes in the class of conductor (as defined in [AS/NZS 1125](#)) require a separate qualification using a 10 mm² three-core and earth sheathed circular cable.
 - (iii) Changes in the flame/fire barrier (i.e. material type or construction, yield, coverage or number of tapes applied) require a separate qualification using a 10 mm² three-core and earth sheathed circular cable.
 - (iv) Screened, braided or armoured multicores constitute a different cable construction and therefore require a separate qualification using a 10 mm² three-core and earth sheathed circular cable. Any metallic covering shall be earthed during the tests.
 - (v) Changes in cable voltage rating require a separate qualification using a 10 mm² three-core and earth sheathed circular cable.
 - (vi) A cable having a different insulation or sheath designation shall be classed as a different 'type of cable' and shall require a separate qualification. The designation of insulation and designation of sheath is as defined in [AS/NZS 3808](#) and a different 'type of cable' is when a different material (as defined in [AS/NZS 3808](#)) is used.
 - (vii) If the cable construction changes from circular to flat, separate qualification is required using a 10 mm² three-core and earth sheathed flat cable.
- (c) For qualification of Group 3, the specimen to be tested shall be a single 1.5 mm² three-core and earth sheathed circular cable. This test shall qualify all other multicore cable sizes, and qualifies the range of constructions such as the 2C+E, 3C+E, 4C+E and any other multicore with earth, with the following exceptions:
- (i) Tests on any other size of cable specifically qualify that size only.

- (ii) Changes in the class of conductor (as defined in [AS/NZS 1125](#)) require a separate qualification using a 1.5 mm² three-core and earth sheathed circular cable.
 - (iii) Changes in the flame/fire barrier (i.e. material type or construction, yield, coverage or number of tapes applied) require a separate qualification using a 1.5 mm² three-core and earth sheathed circular cable.
 - (iv) Screened, braided or armoured multicores constitute a different cable construction and therefore require a separate qualification using a 1.5 mm² three-core and earth sheathed circular cable. Any metallic covering shall be earthed during the tests.
 - (v) Changes in cable voltage rating require a separate qualification using a 1.5 mm² three-core and earth cable sheathed circular cable.
 - (vi) A cable having a different insulation or sheath designation shall be classed as a different 'type of cable' and shall require a separate qualification. The designation of insulation and designation of sheath is as defined in [AS/NZS 3808](#) and a different 'type of cable' is when a different material (as defined in [AS/NZS 3808](#)) is used.
 - (vii) If the cable construction changes from circular to flat, separate qualification is required using a 1.5 mm² three-core and earth sheathed flat cable.
- (d) For qualification of Group 4, the specimens to be tested shall be a two-core sheathed circular cable of the smallest conductor size for which qualification is sought. This test shall qualify all other multicore cable sizes in the Group with the following exceptions:
- (i) Tests on any other size of cable specifically qualify that size only.
 - (ii) Changes in the class of conductor (as defined in [AS/NZS 1125](#)) require a separate qualification using a two-core sheathed circular cable of the smallest conductor size for which qualification is sought.
 - (iii) Changes in the flame/fire barrier (i.e. material type or construction, yield, coverage or number of tapes applied) require a separate qualification using a two-core sheathed cable of the smallest conductor size for which qualification is sought.
 - (iv) Screened, braided or armoured multicores constitute a different cable construction and therefore require a separate qualification using a two-core cable of the smallest conductor size for which qualification is sought. Any metallic covering and/or drain wire shall be earthed during the tests.
 - (v) Changes in cable voltage rating require a separate qualification using a two-core sheathed circular cable of the smallest conductor size for which qualification is sought.
 - (vi) A cable having a different insulation or sheath designation shall be classed as a different 'type of cable' and shall require a separate qualification. The designation of insulation and designation of sheath is as defined in [AS/NZS 3808](#) and a different 'type of cable' is when a different material (as defined in [AS/NZS 3808](#)) is used.
 - (vii) If the cable construction changes from circular to flat, separate qualification is required using a two-core flat sheathed cable of the smallest conductor size for which qualification is sought.

- (e) For qualification of Group 5, the specimens to be tested shall be three 35 mm² cables without serving arranged in a trefoil configuration. This shall qualify all other single-core sizes, with the following exceptions:
- (i) Tests on any other size of cable specifically qualify that size only.
 - (ii) Changes in the flame/fire barrier (i.e. material type or construction) require a separate qualification using 35 mm² cables in the trefoil configuration.
 - (iii) Any metallic layer shall be earthed during the tests.
 - (iv) Changes in cable voltage rating require a separate qualification using 35 mm² cables without serving arranged in a trefoil configuration.
 - (v) Testing of a cable without serving qualifies a cable with serving.
 - (vi) Changes in the construction of the metal sheath (e.g. from drawn tube to seamed construction) require a separate qualification using a 35 mm² cable without serving arranged in a trefoil configuration.
- (f) For qualification of Group 6, the specimens to be tested shall be a single 1.5 mm² three-core circular cable without serving. This test shall qualify all other multicore cable sizes, and qualifies the range of constructions such as the 2C, 3C, 4C, and any other multicore, with the following exceptions:
- (i) Tests on any other size of cable specifically qualify that size only.
 - (ii) Changes in the flame/fire barrier (i.e. material type or construction) require a separate qualification using a single 1.5 mm² three-core cable without serving.
 - (iii) The cable sheath shall be earthed during the tests.
 - (iv) Changes in cable voltage rating require a separate qualification using a single 1.5 mm² three-core cable without serving.
 - (v) Testing of a cable without serving qualifies a cable with serving.
 - (vi) Changes in the construction of the metal sheath (e.g. from drawn tube to seamed construction) require a separate qualification using a single 1.5 mm² three-core circular cable without serving.

A4.2.2 *Arrangement of specimens*

Test specimens shall be arranged so that there are a minimum of two changes of direction, each not less than 90°. Bends in cables shall be made at the minimum bending radius recommended by the manufacturer. In the case of single-core cables in trefoil, the minimum bending radius shall apply to the cable positioned on the inner curvature of the trefoil arrangement.

A4.3 **Busways**

A4.3.1 *Specimens to be tested*

For each type of busway, one specimen of the smallest conductor cross-sectional area (a type is classified according to its materials and methods of construction). These tests shall qualify all other busway sizes of the same type of construction comprising—

- (a) more conductors with the same cross-sectional area; or
- (b) larger conductors with the same number of cores.

A 'type' of busway is classified in accordance with its materials and method of construction. A change in any of the following criteria requires separate qualification:

- (a) Change in insulation method.
- (b) Change in casing material.

(c) Change in joint method.

A4.3.2 Arrangement of specimens

Test specimens shall be arranged so that there are a minimum of two changes of direction, each not less than 90°. Bends in flexible busways shall be made at the minimum bending radius recommended by the manufacturer.

A4.4 Supports and fixings

Supports and fixings shall be tested separately (see Appendix C).

NOTE: Supports or fixings tested as elements of a wiring system do not qualify the individual supports and fixings. The classification obtained can only be applied to the assembled wiring system as tested. (See Clause 1.1).

A4.5 Joints or junction boxes

A4.4.1 Cables

Joints or junction boxes shall be tested using the cables defined in Paragraph A4.2.

The joint or junction box classification shall be assigned in accordance with Table A1.

TABLE A1
CLASSIFICATION RANGE FOR JOINTS AND JUNCTION BOXES

Cable type	Qualifying cable	Range of qualification
Single core cable	Group 1	Group 1
Multicore cable	Group 3	Group 2, 3 and 4
Single core MIMS	Group 5	Group 5
Multicore MIMS	Group 6	Group 6

A4.4.2 Busways

Joints or junction boxes for busways shall be tested using the smallest size of busway for each type of busway. This test shall qualify all other busways of the same type.

A4.6 Earthing of metal parts

All metal parts of the support and fixing system shall be earthed during the test.

A4.7 Testing of more than one cable group or busway

It is permissible to test cables from more than one group in the one test. The requirements of the Standard shall be met and specimens so arranged shall be separated by at least 25 mm.

It is permissible to test two or more busways in the one test. The requirements of the Standard shall be met and busways so arranged shall be separated by at least 25 mm.

A5 APPARATUS

A5.1 Required apparatus

The following apparatus is required:

- (a) A horizontal furnace complying with the requirements of [AS 1530.4](#).
- (b) A circuit integrity monitoring system (see Figure A1) to perform the following tasks:
 - (i) Continually assess the circuit integrity of each live conductor when carrying a current of at least 0.25 A.

- (ii) Detect whether any conductor ceases conducting.
 - (iii) Detect whether any live conductor comes into contact with any other conductor, screen, armour or earthed metal.
- (c) For the testing of cables in Groups 1 to 4, a 450 mm wide steel cable tray which shall be fixed to the specimen mounting slab that constitutes the roof of the furnace (see Figure A2).

The base metal thickness of the cable tray shall not be less than 0.7 mm or greater than 1.2 mm. The tray shall be of perforated construction with a metal to air ratio in the range 65/35 to 75/25.

NOTE: TYCO Riteway Cable Tray has been found to comply.*

- (d) For the testing of cables in Groups 5 and 6, the cables shall be fixed with MIMS cable clamps to preformed metal channel which shall, in turn, be fixed to the specimen mounting slab that constitutes the roof of the furnace (see Figure A3).

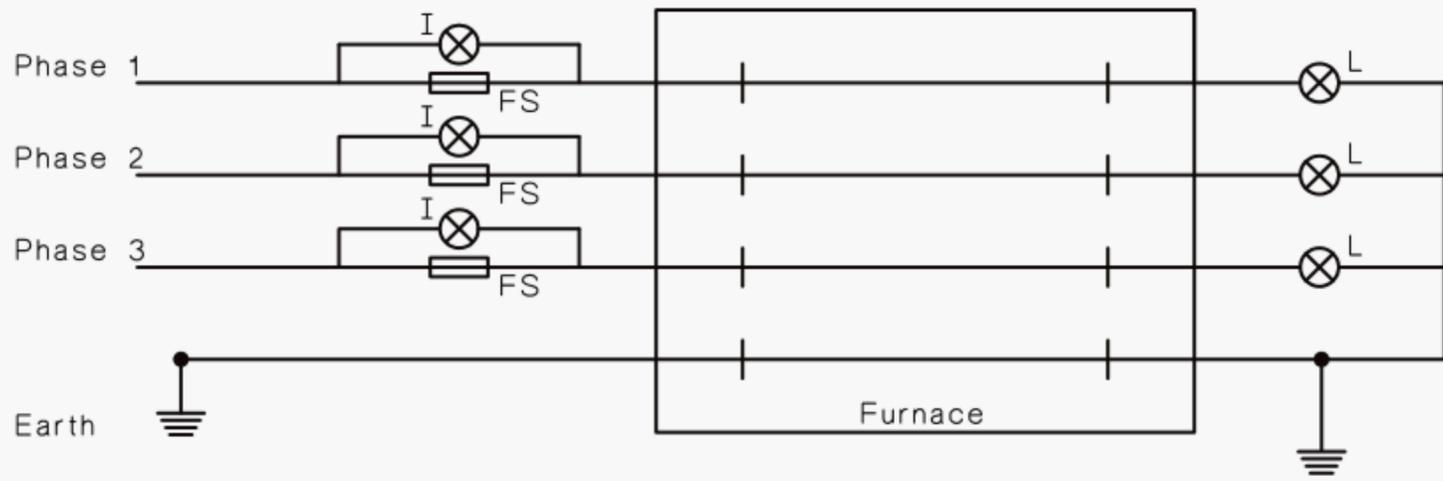
A5.2 Monitoring system

A circuit integrity monitoring system satisfying the requirements listed in Paragraph A5.1 may be constructed by means of a multiphase supply (see Figure A1(a)) or a single-phase supply (see Figure A1(b)) with each cable conductor of the cable under test connected across a 60 W lamp. For all cables tested, each live conductor is to be connected to a separate phase or to the neutral as appropriate. Adjacent conductors shall not be connected to the same phase.

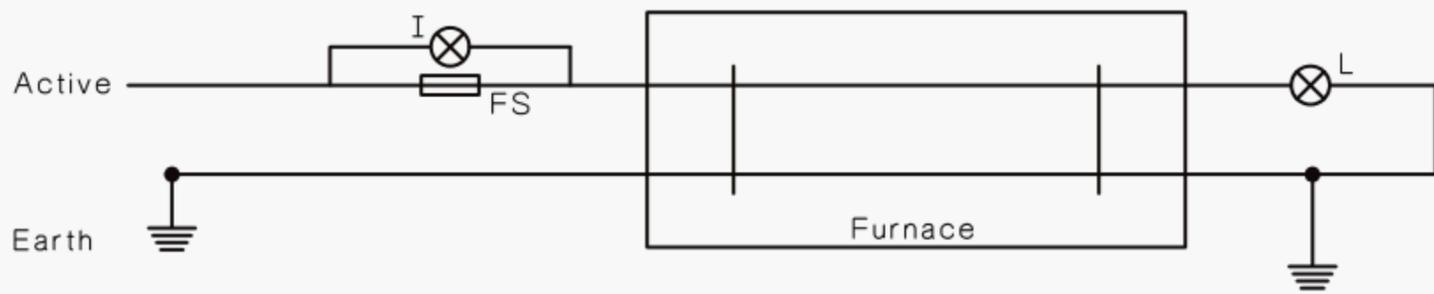
Each live conductor shall be protected by an HRC fuse of a nominal rating of not more than 4 A.

The prospective fault level of the test circuit shall be high enough to allow a fuse to operate in less than one cycle if any conductor comes into contact with another conductor, screen, armour or earthed metal.

* Tyco Riteway Cable Tray is an example of a suitable product available commercially. This information is given for the convenience of users of this Standard and does not constitute an endorsement by Standards Australia or Standards New Zealand of this product.



(a) Using a multiphase supply to test groups 1, 2, 3, 5 and 6



(b) Using a single-phase supply to test group 4

LEGEND:
 FS = Fuse
 L = Tungsten lamp
 I = Indicating lamp

FIGURE A1 TYPICAL CIRCUIT INTEGRITY MONITORING SYSTEMS

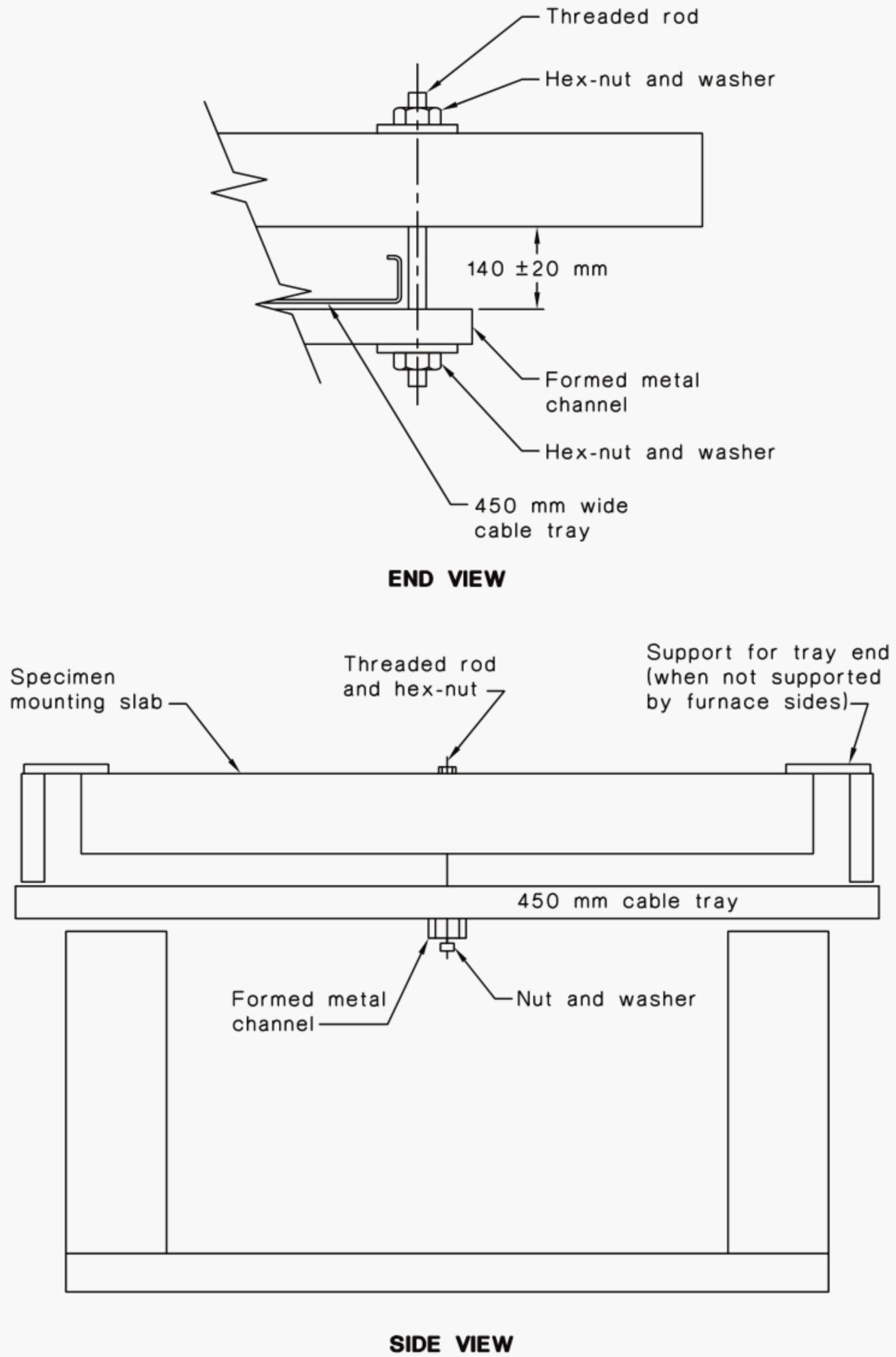
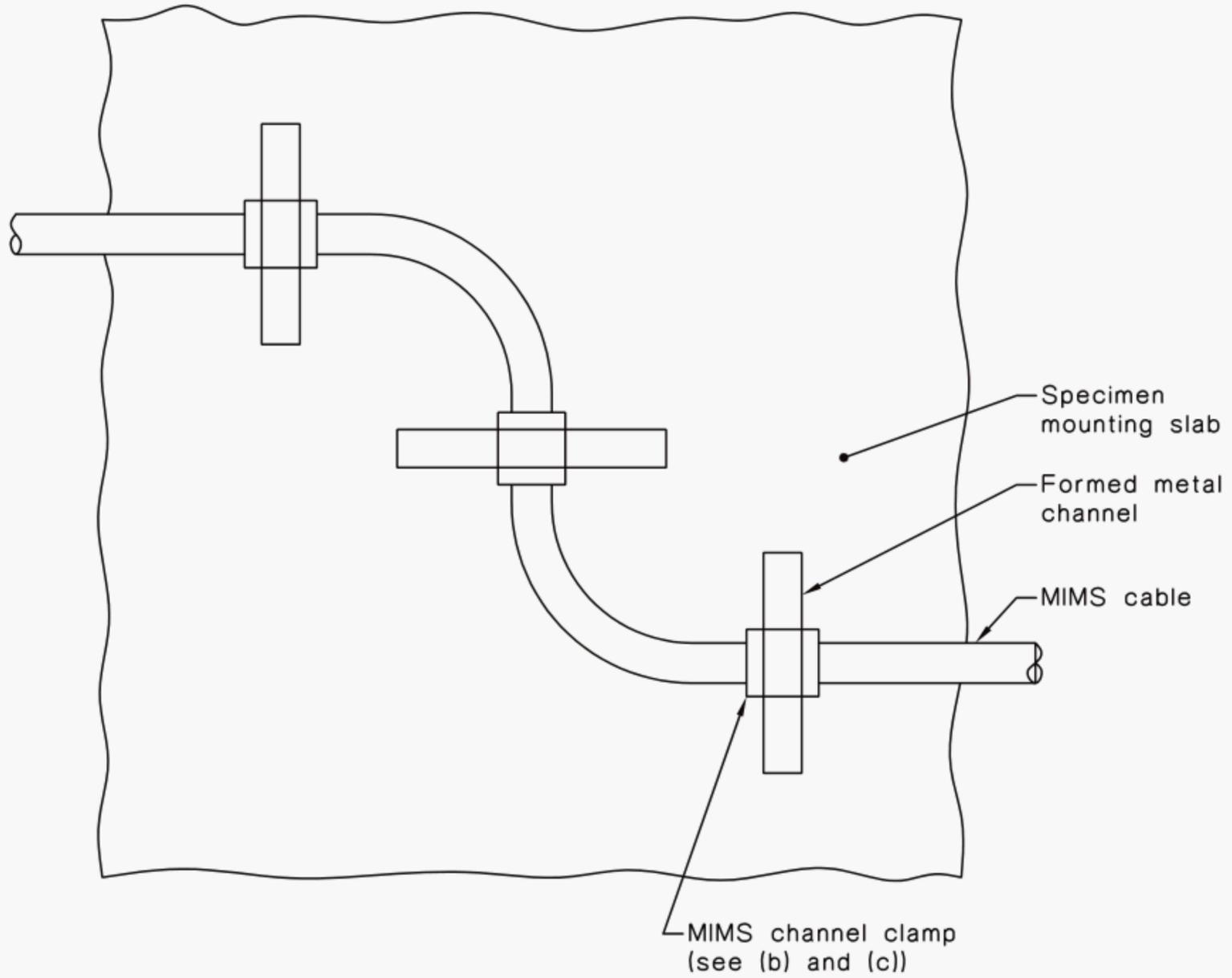
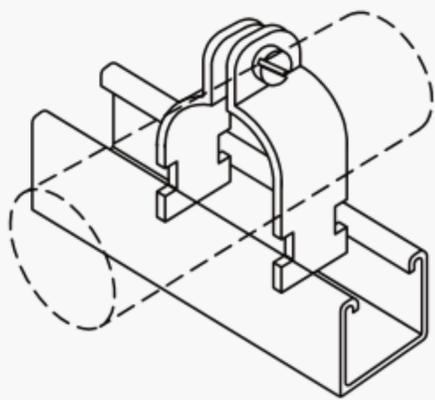


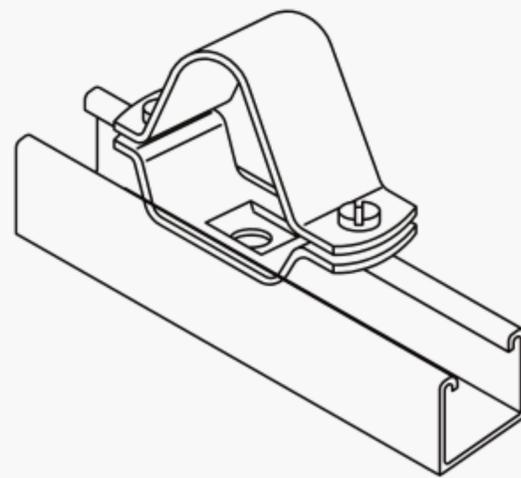
FIGURE A2 ARRANGEMENT FOR TESTING OF CABLES IN GROUPS 1 TO 4



(a) Arrangement for testing of cables in groups 5 and 6



(b) Single cable clamp
(One single-core or one multicore cable)



(c) Trefoil cable clamp
(Three single-core cables)

FIGURE A3 ARRANGEMENT FOR TESTING OF CABLES IN GROUPS 5 AND 6

A6 PROCEDURE

The procedure shall be as follows:

A6.1 Busways

- (a) Using the manufacturers instructions, mount the busway test specimen to the specimen mounting slab forming the roof of the furnace. More than one specimen may be tested in a test provided that the specimens under test do not interact. The method of fixing of the busway shall be included in the test report.
- (b) The busway enclosure shall be earthed.

A6.2 Cables

- (a) Mount the cable test specimen(s) onto the metal cable tray, such that the first directional change is clockwise and the second is anti-clockwise (or vice versa). A metallic cable tie shall firmly hold the cable(s) to the tray at the centre of the two directional changes. The cable shall then be held to the tray utilizing a number of non-metallic cable ties sufficient to hold the specimen(s) in the correct configuration and minimum bending radius, prior to the start of the test.
- (b) Using the channel trapeze, mount the metal tray to the specimen mounting slab forming the roof of the furnace, as shown in Figure A2.
- (c) Additional support bricks may be required on top of the furnace walls to support the specimen mounting slab forming the roof of the furnace. This is to allow the metal tray ends to exit the furnace (see Figure A2). Any gaps formed to allow the metal tray exits shall be adequately filled with heat-resistant material to enable the furnace to be operated in accordance with [AS 1530.4](#).
- (d) Any metallic covering within the cables (e.g. screens, braids or armour and all the metallic parts of the support and fixing system) shall be earthed.

A6.3 MIMS cables

- (a) Mount the metal channels to the specimen mounting slab forming the roof of the furnace, as shown in Figure A3.
- (b) Mount the MIMS test specimen(s) onto the metallic channels. A metallic cable clamp, suitable for use with the channel, shall firmly hold the cable(s) to the channel at the centre of the two directional changes. Additional cable clamps may be required to hold the specimen(s) in the correct configuration and minimum bending radius prior to the start of the test.
- (c) The metal sheath of the cables shall be earthed.

A6.4 Common procedure

- (a) Connect the circuit integrity monitoring system. Cables nominally rated for 450/750 V or 600/1000 V, shall be tested at a voltage of at least 230/400 V. Cables of other voltage rating shall be tested at the voltage nominated by the submitter. The test voltage shall be recorded in the test report.
- (b) Energize the circuit(s) and visually check for correct operation.
- (c) Operate the furnace in accordance with the test procedures of [AS 1530.4](#) for furnace ignition, standard heating conditions, and control of furnace temperature and pressure, except that the initial temperature shall be taken as 20°C for the calculation of the time–temperature curve.
- (d) Record the performance of the cable or busway under test at intervals of no more than 5 min for the first 30 min, thence at intervals of no more than 15 min.

- (e) The test shall be continued in the prescribed manner until—
 - (i) 120 min has elapsed; or
 - (ii) subject to agreement between the testing authority and the submitter, one or more specimens under test have failed; or
 - (iii) the time prescribed by the submitter has elapsed.
- (f) On request by the submitter, a water test (see Appendix B) shall be conducted.

A7 TEST CRITERIA

A cable or busway is deemed to have passed when the specimen(s) have been exposed to the test for the appropriate minimum time requested by the submitter without a failure.

A cable or busway shall be considered to have failed when any of the specimens fail, including, in the case of the trefoil single core cables, any one of the three cables in trefoil.

A specimen shall be considered to have failed if the circuit integrity monitoring system indicates that—

- (a) any live conductor is not carrying the test current; or
- (b) any live conductor has made electrical contact with another conductor; or
- (c) any live conductor has made electrical contact with a screen, armour or earthed metal; or
- (d) the earthing conductor becomes an open circuit.

A8 REPORTING OF RESULTS

The test report shall include—

- (a) sufficient detail to uniquely identify each specimen(s);
- (b) the time taken from the start of the test to the completion of the test;
- (c) the resultant wiring system (cable or busway) classification;
- (d) the applied test voltage;
- (e) for busways, the method of fixing;
- (f) for cables, the cable configuration on the metal tray;
- (g) observations by the testing authority; and
- (h) the time/temperature curve and/or data and the furnace pressure during the test(s).

In the event of a test failure, the test report shall include—

- (i) sufficient detail to uniquely identify the specimen;
- (ii) the time taken from the start of the test to the occurrence of failure;
- (iii) a report of the nature of the failure (in the case of testing cables, which and how many of the cable cores are involved); and
- (iv) the mode of failure, e.g. core-to-core, core-to-earth.

A9 RETENTION OF SPECIMENS

A specimen, sufficient to uniquely identify the sample, shall be retained by the testing authority, whether the sample has met the criteria by the submitter or has failed.

A10 RETESTING OF SAMPLES

In the event of a failure, the test(s) may be repeated on two identical specimens (or trefoil arrangement of specimens for Group 1 or Group 5 cables) in the same configuration and mounting. If both these specimens pass the test(s) then the cable or busway shall be deemed to have passed. If either of these repeat test specimens fails the test, then the sample is deemed to have failed.

At the discretion of the submitter, the cable or busway shall be deemed to have failed, either after a test failure (Paragraph A7) or after a failure during re-testing (this Paragraph A10).

Once deemed to have failed, the submitter shall not re-submit the same cable or busway for test, unless a significant change is made to the cable or busway. Examples of 'significant change' are any of those listed in Paragraph A4 which are deemed to require a separate qualification.

A11 CLASSIFICATION

A cable or busway is deemed to have achieved the desired degree of protection when none of the specimen(s) have failed and the specimen(s) have been exposed to the test for the appropriate minimum time defined in Table 3.1.

APPENDIX B
WATER TEST METHOD—CABLES AND BUSWAYS
(Normative)

B1 SCOPE

This Appendix sets out a test method that assesses the ability of a cable or busway to maintain circuit integrity when subject to both fire conditions and spraying with water.

B2 APPLICATION

This method applies to unenclosed cables and busways.

B3 PRINCIPLE

A specimen of the cable or busway is placed in a furnace, and tested in accordance with Appendix A. After the specimen has been in the furnace for the required period, it is removed from the furnace and exposed to a water spray.

B4 TEST SPECIMENS

Test specimens shall be in accordance with Paragraph A4.

B5 APPARATUS

The following apparatus is required:

- (a) A horizontal furnace complying with Paragraph A5.1(a), Appendix A.
- (b) A circuit integrity monitoring system complying with Paragraph A5.1(b), Appendix A.
- (c) A water spray test rig incorporating a nozzle and piping arrangement as detailed in Figure B1.

NOTE: Figure B1 shows the testing of cable. The same procedure applies to busways, supports and fixings.

The nozzle shall be ½" BSP male brass nozzle Model N1 (90°) manufactured by BETE (USA).*

* The BETE nozzle is the trade name of a product supplied in Australia by Spray Nozzle Engineering Pty Ltd. This information is given for the convenience of users of this Standard and does not constitute an endorsement by Standards Australia or Standards New Zealand of the product name. Equivalent products may be used if they can be shown to lead to the same results.

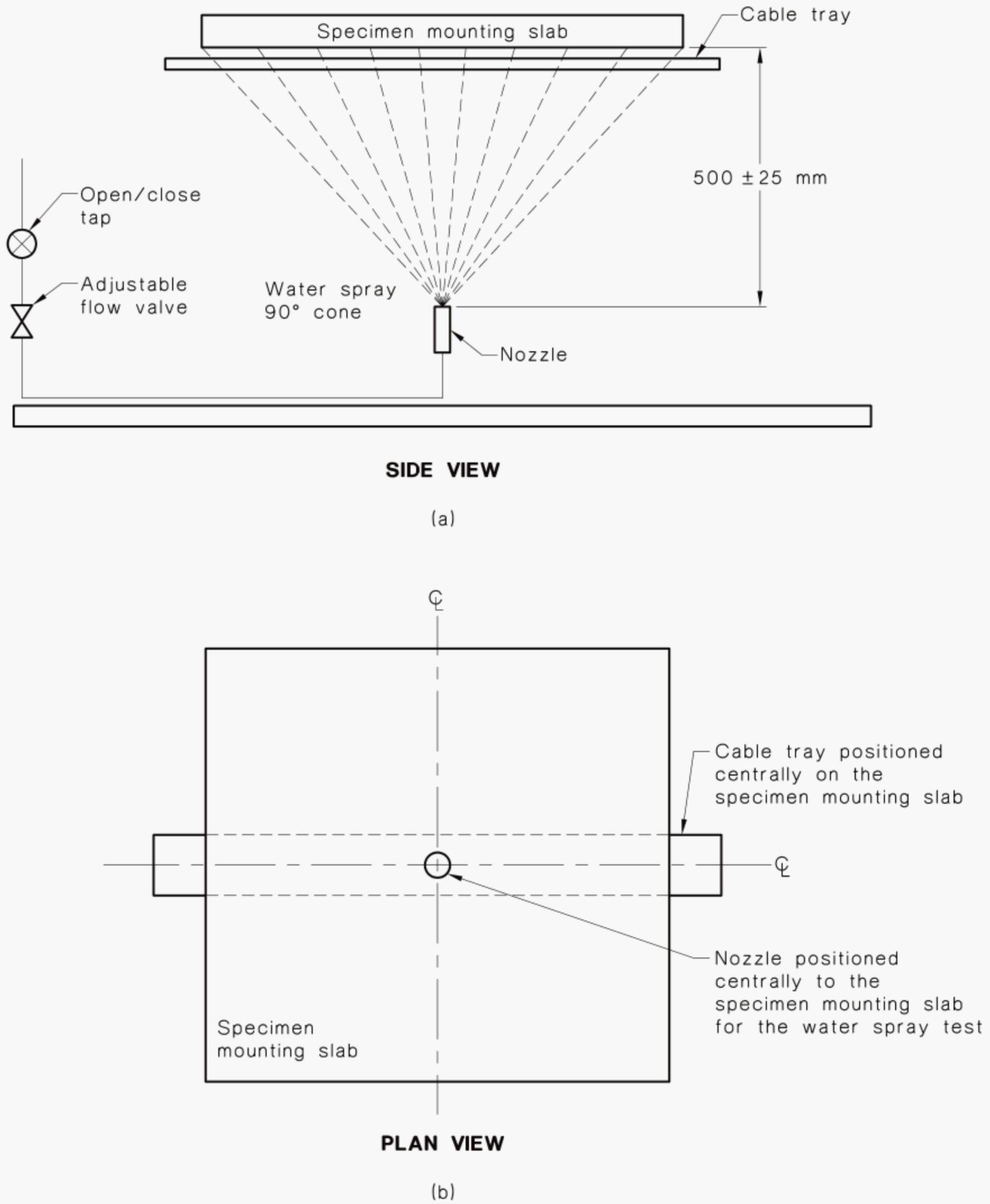


FIGURE B1 WATER SPRAY TEST RIG

B6 PROCEDURE

The procedure shall be as follows:

- (a) Test the specimen in accordance with Paragraph A6, for the time necessary to attain the desired first characteristic numeral (see Table 3.1).

- (b) Remove the specimen mounting slab from the furnace and mount it horizontally on the supports in the water spray test rig. Connections to the circuit integrity monitoring system may be removed while the slab is being moved. The circuit integrity of the specimen need not be monitored during the period after its removal from the furnace and prior to being sprayed with water.
- (c) At no time before the water spray test shall any means be used to cool the slab and/or test specimen(s).
- (d) The test shall be conducted in a draft free environment or externally where the wind speed measured by an anemometer does not exceed 8 m/s.
- (e) Within 10 min \pm 30 s after the completion of Step (a), the slab shall be in position and the water spray shall be activated. Within 5 s the water flow rate shall reach a value of 12.5 l/min.
- (f) Monitor the circuit integrity of the specimen(s) while the specimen(s) are being sprayed with water.
- (g) The water spray test shall be continued in the prescribed manner until 180 s has elapsed.

B7 TEST CRITERIA

A cable or busway is deemed to have achieved the desired degree of protection when none of the specimen(s) have failed, the specimen(s) having been exposed to the fire test for the appropriate minimum time defined in Table 3.1 and the specimens have sustained the effects of the water spray.

A cable or busway shall be considered to have failed when any of the specimens fail.

A specimen shall be considered to have failed, if the circuit integrity monitoring system indicates that—

- (a) any live conductor is not carrying the test current; or
- (b) any live conductor has made electrical contact with another conductor; or
- (c) any live conductor has made electrical contact with a screen, armour or earthed metal; or
- (d) the earthing conductor in the cable or busway becomes an open circuit.

B8 REPORTING OF RESULTS

The test report shall include—

- (a) sufficient detail to uniquely identify each specimen;
- (b) the time taken from the start of the fire test to the completion of the water spray test;
- (c) a statement that the system has been subjected to the water spray test; and
- (d) whether the 'W' in the wiring system classification was achieved and the specimen can be classified accordingly.

In the event of a test failure, the test report shall include—

- (i) sufficient detail to uniquely identify each specimen;
- (ii) the time taken from the start of the water spray test to the occurrence of failure;
- (iii) a report of the nature of the failure (in the case of testing cables, which and how many of the cable cores are involved); and
- (iv) the mode of failure, e.g. core-to-core, core-to-earth.

B9 RETENTION OF SPECIMENS

A specimen, sufficient to uniquely identify the sample, shall be retained by the testing authority, whether the sample has met the criteria by the submitter or has failed.

B10 RETESTING OF SPECIMENS

In the event of a failure, the test(s) may be repeated on two identical specimens (or trefoil arrangement of specimens for Group 1 or Group 5 cables) in the same configuration and mounting. If both these specimens pass the test(s) then the cable or busway shall be deemed to have passed. If either of these repeat test specimens fails the test, then the sample is deemed to have failed.

At the discretion of the submitter, the cable or busway shall be deemed to have failed, either after a test failure (Paragraph B7) or after a failure during re-testing (this Paragraph B10).

Once deemed to have failed, the submitter shall not re-submit the same cable or busway for test, unless a significant change is made to the cable or busway. Examples of 'significant change' are any of those listed in Paragraph A4, which is deemed to require a separate qualification.

B11 CLASSIFICATION

A cable or busway is deemed to have achieved the desired degree of protection when none of the specimens have failed and the specimens have been exposed to the requirements of this Appendix B, following the successful completion of the requirements of Appendix A.

APPENDIX C
FIRE TEST METHOD—SUPPORTS AND FIXINGS
(Normative)

C1 SCOPE

This Appendix sets out a test method to determine the suitability of supports and fixings for supporting elements of wiring systems under fire conditions.

C2 APPLICATION

Supports and fixings are deemed to be suitable for use with cables or busways if the calculated load for the cables or busways is equal to or less than the load used in the test.

C3 PRINCIPLE

Specimens of supports and fixings are mechanically loaded and placed in a furnace in order to determine the suitability of supports and fixings to support wiring system elements under fire conditions. The furnace is operated in accordance with the test procedures of [AS 1530.4](#) for furnace ignition, standard heating conditions, and control of furnace temperature and pressure, except that the initial temperature shall be taken as 20°C for the calculation of the time–temperature curve.

C4 TEST SPECIMENS

C4.1 Supports

The following requirements, as appropriate, shall apply to specimens under test:

- (a) At least one specimen of each type of support shall be tested.
- (b) A ‘type’ of support is classified in accordance with its material and method of construction. Changes in any of the criteria listed below require separate qualification:
 - (i) Material type, e.g. mild steel or stainless steel.
 - (ii) Material thickness: sheet, rod or bar.
 - (iii) Ladder, tray or other design.
 - (iv) Air/metal ratio differing by more than 10% than that tested.
 - (v) Pressed or rolled method of manufacture.
 - (vi) Increase in tray or ladder width.

C4.2 Fixings

- (a) Ten specimens of each type and each size of fixing shall be tested.
- (b) A ‘type’ of fixing is classified in accordance with its material and method of construction. Changes in any of the criteria below require separate qualification:
 - (i) Change in material used in construction of the fixing, e.g. mild steel or stainless steel.
 - (ii) Change in the design of the fixing.

Changes in the coating material of a fixing do not constitute a change in type and do not require a separate test.

C5 APPARATUS

A horizontal furnace complying with the requirements of AS 1530.4.

C6 PROCEDURE

The procedure shall be as follows:

- (a) Supports shall be fixed to the specimen mounting slab, in at least two locations, at the nominated support span. The test specimen shall remain at least 100 mm clear of the furnace walls during the test. The ends of the cable tray/ladder may be secured so that the system simulates a continuous run.
- (b) Load the test specimen with a static mass equal to the load nominated by the submitter.
- (c) Where a cable tray, cable ladder or other support is under test, loading shall be simulated by lengths of 6 mm diameter mild steel rods at least as long as the support span of the specimen under test.
- (d) Where the test is of fixings (e.g. expanding metal sleeve devices or metal cable ties), concentrated loads may be used.
- (e) Operate the furnace in accordance with the test procedures of AS 1530.4 for furnace ignition, standard heating conditions, and control of furnace temperature and pressure, except that the initial temperature shall be taken as 20°C for the calculation of the time–temperature curve.
- (f) The test shall be continued in the prescribed manner until—
 - (i) 120 min has elapsed; or
 - (ii) subject to agreement between the testing authority and the submitter, one or more specimens under test have failed; or
 - (iii) the time prescribed by the submitter has elapsed.
- (g) Measure and record the final position of the test specimen. Measurements are made once the specimen under test has cooled to ambient temperature.

C7 TEST CRITERIA

A sample shall be considered to have failed if—

- (a) any specimen fails to support its load;
- (b) any part of the support is vertically deflected by more than 100 mm from its position at the start of the test;
- (c) any fixing dislodges from the specimen mounting slab.

C8 REPORTING OF RESULTS

The test report shall include sufficient detail to uniquely identify each specimen and shall indicate the final position of all items under test.

Additionally, the test report may indicate the mode of failure and include a report of a physical examination of the specimens after the test.

The test report shall include—

- (a) sufficient detail to uniquely identify the specimens;
- (b) the time taken from the start of the test to the completion of the test;
- (c) the method of fixing the support element to the specimen mounting slab; and

- (d) observations by the testing authority.

C9 RETENTION OF SPECIMENS

A specimen, sufficient to uniquely identify the sample, shall be retained by the testing authority, whether the sample has met the criteria by the submitter or has failed.

C10 RETESTING OF SPECIMENS

In the event of a failure of a support, the test(s) may be repeated on two identical specimens in the same configuration and mounting. If both these specimens pass the test(s) then the supports shall be deemed to have passed. If either of these repeat test specimens fails the test, then the support is deemed to have failed.

In the event of failure of a fixing, two further tests must be conducted. In each further test ten specimens of the sample shall be re-tested. If both these further tests are successful, the fixing shall be deemed to have passed. If either of these further tests results in failure the fixing shall be deemed to have failed.

At the discretion of the submitter, the supports and fixings shall be deemed to have failed, either after a test failure (Paragraph C7) or after a failure during re-testing (this Paragraph C10).

C11 CLASSIFICATION

A support or fixing is deemed to have achieved a desired degree of protection when the sample has been tested in accordance with this Appendix and has not failed.

APPENDIX D
MECHANICAL TEST METHOD—IMPACT TEST
(Normative)

D1 SCOPE

This Appendix sets out a test method for assessing the ability of unenclosed cables, busways and wiring enclosures, to withstand mechanical impact.

D2 APPLICATION

This test applies to the following:

- (a) Unenclosed cables and busways (tested in accordance with Paragraph D6.1).
- (b) Circular wiring enclosures, such as conduits and pipes (tested in accordance with Paragraph D6.2).
- (c) Non-circular wiring enclosures, such as ducts and other cable enclosures (tested in accordance with Paragraph D6.3).

D3 PRINCIPLE

This test applies direct impacts to an element of a wiring system to assess its ability to withstand mechanical impact.

D4 TEST METHODOLOGY

The following requirements shall apply to specimens under test:

- (a) One specimen of each type of unenclosed cable, busway, or wiring enclosure shall be tested.
- (b) All specimens shall be at least 400 mm long. In the case of cable specimen, the exposed core(s) shall extend beyond the 400 mm specimen length.
- (c) All specimens shall be tested at an ambient air temperature of $23 \pm 3^\circ\text{C}$.
- (d) Tests shall be carried out with the specimens pre-conditioned to each extreme of the proposed operating temperature range. Such temperatures shall be selected from the following values in degrees Celsius:

-25, -15, 0, +5, +40, +60, +75, +90, +110.

Specimens shall be prepared for test by being conditioned for 4 h at the test temperature. The conditioning chamber shall be maintained at the test temperature $\pm 3^\circ\text{C}$ or $\pm 3\%$, whichever is the greater.

- (e) Determine the height from which the impactor is dropped from the following equation:

$$h = \frac{J}{g.m} + (\text{height of specimen})$$

where

- h = drop height, in metres (minimum of 0.1 m, see Paragraph D5)
 J = impact load, in joules (see Column 2 of Table 3.2)
 g = gravitational acceleration, in metres per second squared
 m = total mass of impactor and adjustable masses, in kilograms.

D5 APPARATUS

The following apparatus is required:

- (a) Apparatus similar to that shown in Figure D1. The apparatus shall have the following characteristics:
- Minimum drop height 0.1 m
 Drop height setting tolerance +5.0, -10 mm
 Falling mass tolerance $\pm 0.5\%$
- (b) Moulding putty or similar material for retaining impressions.
- (c) A circuit integrity monitoring system as specified in Paragraph A5.1(b), but augmented with a transformer (or transformers) and lamps and/or neon indicators to enable the test to be conducted at an ELV voltage of between 18 and 30 volts r.m.s. between conductors and earth.
- (d) The dimensions of the apparatus shall comply with the following:
- (i) Length of support, (A) for the specimen provided by the anvil shall be 400 mm, ± 5 mm.
- (ii) The height of the anvil, (B) shall be no less than 30 mm and need be no greater than 60 mm.
- (iii) The anvil, (C) shall be constructed of steel and shall be supported on a concrete base.
- (iv) The width of the impactor, (D) shall be 200 mm, ± 2 mm.
- (v) The height of the impactor, (E) shall be a minimum of 50 mm.
- (vi) The length of the exposed cable cores (F) shall be a minimum of 0.5 times the height of the specimen.

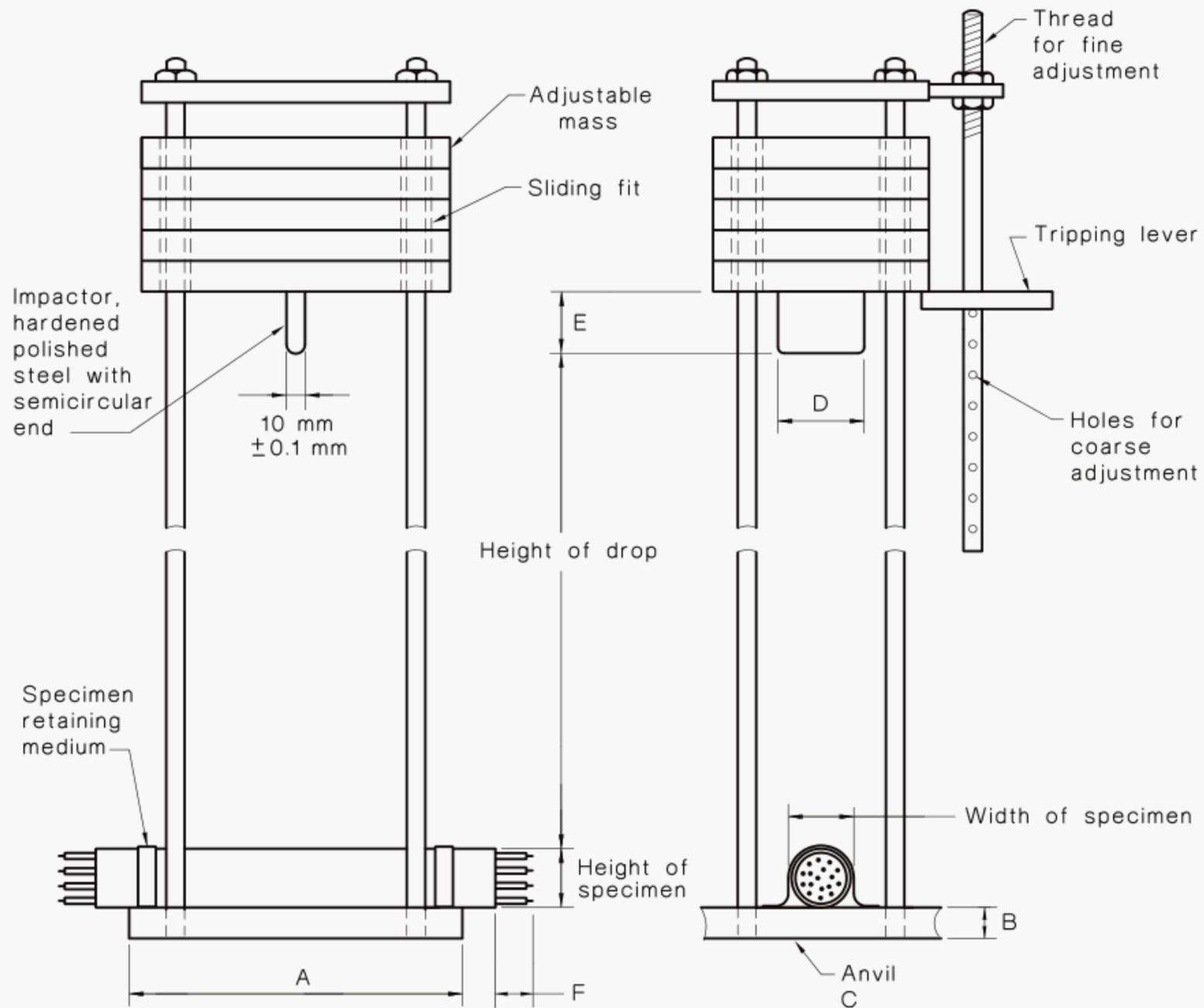


FIGURE D1 IMPACT TEST LOAD ASSEMBLY

D6 PROCEDURE

D6.1 Procedure—Cables and busways

The procedure for unenclosed sheathed cables and busways shall be as follows:

- (a) Set the impactor at the drop height.
- (b) Remove the specimen from the conditioning chamber and fix centrally on the anvil of the test apparatus. Non-circular busways shall be fixed to the anvil with the same orientation that is to be used when they are installed. Flat cables shall be tested across both the minor and major axis. Busways that can be installed in more than one formation shall be tested in each formation. Simple retaining methods which restrain the specimen from moving are acceptable.
- (c) Connect the circuit integrity monitoring system to the conductors and connect an earth to the impact test load assembly.
- (d) Apply the first impact to the specimen within 60 s of the removal of the specimen from the conditioning chamber and complete all three impacts within 300 s. Apply each impact to the specimen in the same location.
- (e) Record the results.

D6.2 Procedure—Circular wiring enclosures

The procedure for circular wiring enclosures, such as conduits and pipes tested without containing cables, shall be as follows:

- (a) Set the impactor at the drop height.
- (b) Remove the specimen from the conditioning chamber and fix the specimen centrally on the anvil of the test apparatus. Simple retaining methods which restrain the specimen from moving are acceptable.
- (c) Apply the first impact to the specimen within 60 s of the removal of the specimen from the conditioning chamber and complete all three impacts within 300 s. Apply each impact to the specimen in the same location.
- (d) Following the three impacts, measure the transient or permanent reduction in diameter using either of the following methods or another method of equal or greater accuracy:
 - (i) Measure the deformation of a cylinder of moulding putty wrapped in thin food wrap film and inserted in the specimen. The diameter of the moulding putty shall be less than the internal diameter of the specimen to allow insertion and withdrawal, and shall be large enough to record the transient reduction in diameter.
 - (ii) When the impactor has sufficient width, mounds of moulding putty, of the same height or no more than 2 mm larger than the diameter of the test specimen, may be placed on either side of the specimen so that they will retain the impression of the maximum fall position of the impactor. The reduced internal diameter of the specimen is calculated by averaging the two moulding putty height measurements and subtracting twice the specimen wall thickness.
- (e) Record the results.

D6.3 Procedure—Non-circular wiring enclosures

The procedure for non-circular wiring enclosures, such as ducts and other enclosures, shall be as follows:

- (a) Set the impactor at the drop height.
- (b) Remove the specimen from the conditioning chamber and fix the specimen centrally on the anvil of the test apparatus. The specimen shall be arranged with the same orientation that is to be used when it is installed. Simple retaining methods which restrain the specimen from moving are acceptable.
- (c) Apply the first impact to the specimen within 60 s of the removal of the specimen from the conditioning chamber and complete all three impacts within 300 s. Apply each impact to the specimen in the same location.
- (d) Following the three impacts, measure the transient or permanent reduction in height using either of the following methods or another method of equal or greater accuracy:
 - (i) Measure the deformation of a cylinder of moulding putty wrapped in thin food wrap film and inserted in the specimen. The height of the moulding putty shall be less than the internal height of the specimen to allow insertion and withdrawal, and shall be large enough to record the transient reduction in height.

- (ii) When the impactor has sufficient width, mounds of moulding putty, of the same height or no more than 2 mm larger than the height of the test specimen, may be placed on either side of the specimen so that they will retain the impression of the maximum fall position of the impactor. The reduced internal height of the specimen is calculated by averaging the two moulding putty height measurements and subtracting twice the specimen wall thickness.

D7 TEST CRITERIA

D7.1 Cables and busways

A cable or busway is deemed to have passed when the specimen has been exposed to the level of impact energy specified in Table 3.2 without failure.

Cables and busways shall be considered to have failed if the circuit integrity monitoring system indicates that—

- (a) a conductor is not carrying the test current;
- (b) a conductor has made contact with another conductor;
- (c) a conductor has made contact with a screen, armour or earthed metal; or
- (d) a conductor has made contact with the impact test load assembly.

D7.2 Enclosures

An enclosure is deemed to have passed when the specimen has been exposed to the level of impact energy specified in Table 3.2 without failure.

Enclosures shall be considered to have failed when—

- (a) an enclosure splits or cracks; or
- (b) an enclosure has its internal diameter/height reduced by more than 40%, either permanently or transiently.

D8 REPORTING OF RESULTS

The test report shall include—

- (a) sufficient detail to uniquely identify each specimen under test;
- (b) the temperature at which the specimen was conditioned;
- (c) the resultant cable, busway or enclosure, impact test classification; and
- (d) in the event of a test failure the test report shall include—
 - (i) sufficient detail to uniquely identify the specimen tested;
 - (ii) sufficient detail to identify the mode of failure; and
 - (iii) the impact energy in Joules at which the specimen failed.

D9 RETENTION OF SPECIMENS

A specimen, sufficient to uniquely identify the sample, shall be retained by the testing authority, whether the sample has met the criteria by the submitter or has failed.

D10 RETESTING OF SPECIMENS

In the event of a failure, the test(s) may be repeated on two identical specimens in the same configuration and mounting. If both these specimens pass the test(s) then the cable, busway, or enclosure shall be deemed to have passed. If either of these repeat test specimens fails the test, then the sample is deemed to have failed.

At the discretion of the submitter, the cable, busway, or enclosure shall be deemed to have failed, either after a test failure (Paragraph D7) or after a failure during re-testing (this Paragraph D10).

Once deemed to have failed, the submitter shall not re-submit the same cable, busway, or enclosure for test, unless a significant change is made to the cable, busway, or enclosure. Examples of 'significant change' for cables or busways are any of those listed in Paragraph A4 which are deemed to require a separate qualification.

D11 CLASSIFICATION

D11.1 Cables and Busway

D11.1.1 Cables

For any cable tested, the same impact test classification shall be deemed to apply to any cable of the same construction comprising—

- (a) more conductors with the same cross-sectional area; or
- (b) larger conductors with the same number of cores.

D11.1.2 Busways

For any busway tested, the same impact test classification shall be deemed to apply to any busway of the same construction comprising—

- (a) more conductors with the same cross-sectional area; or
- (b) the same or greater number of larger conductors.

A 'type' of busway is classified in accordance with its materials and method of construction. A change in any of the following criteria requires separate qualification:

- (i) Change in insulation method.
- (ii) Change in casing material.

D11.2 Enclosures

For any enclosure tested the same impact test classification shall be deemed to apply to any enclosure of the same construction as that tested providing that the wall thickness of the material is equal to or greater than that tested.

APPENDIX E
MECHANICAL TEST METHOD—CUTTING TEST
(Normative)

E1 SCOPE

This Appendix sets out a test method for assessing the ability of unenclosed sheathed cables and non-metallic wiring enclosures to withstand cutting action. Busways are not subject to this test.

E2 APPLICATION

This test applies to—

- (a) unenclosed sheathed cables; and
- (b) non-metallic enclosures.

E3 PRINCIPLE

A wedge-shaped indenter is forced against the specimen and loaded until it cuts through the cable insulation or enclosure or until the withstand load is exceeded, in order to determine the ability of a wiring system element to withstand cutting action.

E4 TEST METHODOLOGY

The following requirements shall apply to specimens under test:

- (a) One specimen of each type of cable and non-metallic enclosure shall be tested.
- (b) Specimens shall not be less than 400 mm long. In the case of cable specimens, the exposed core(s) shall extend beyond the 400 mm specimen length.
- (c) All tests shall be performed at an ambient air temperature of $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- (d) Tests shall be carried out with specimens pre-conditioned to each extreme of the proposed operating temperature range. Such temperatures shall be selected from the following values in degrees Celsius:

–25, –15, 0, +5, +40, +60, +75, +90, +110.

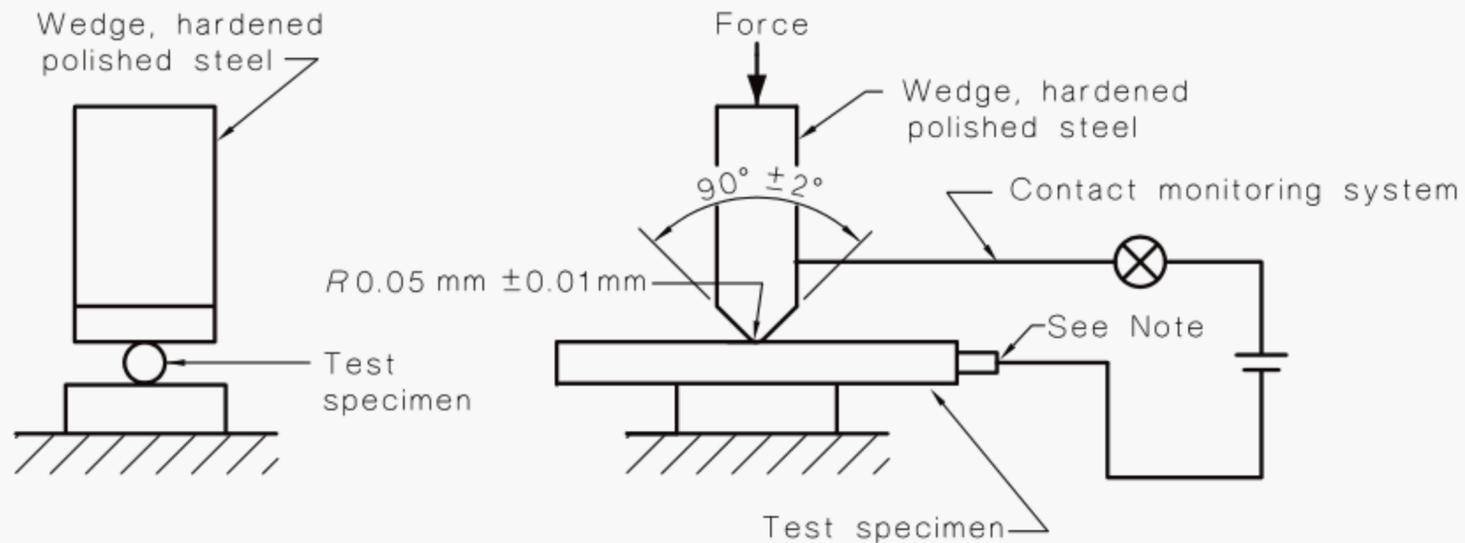
Specimens shall be prepared for test by being conditioned for 4 h at the selected test temperature. The conditioning chamber shall be maintained at the test temperature $\pm 3^{\circ}\text{C}$ or $\pm 3\%$, whichever is the greater.

- (e) Arrange the monitoring system for cables as shown in Figure E1. For a non-metallic enclosure, a metallic rod or pipe shall be fitted snugly into the test specimen and connected to the monitoring system (see Figure E2).

E5 APPARATUS

The following apparatus is required:

- (a) Test apparatus, similar to that illustrated in Figures E1 and E2, mounted in a compression testing machine.
- (b) A contact monitoring system connected as shown in Figures E1 and E2, with a voltage source providing a 9 ± 2 Volts d.c. voltage and an indicating device which shall be either a lamp/neon indicator or audible device (e.g. bell or buzzer).



NOTE: All conductors shall be joined to the contact monitoring system.

FIGURE E1 CUTTING TEST ARRANGEMENT
(Cables)

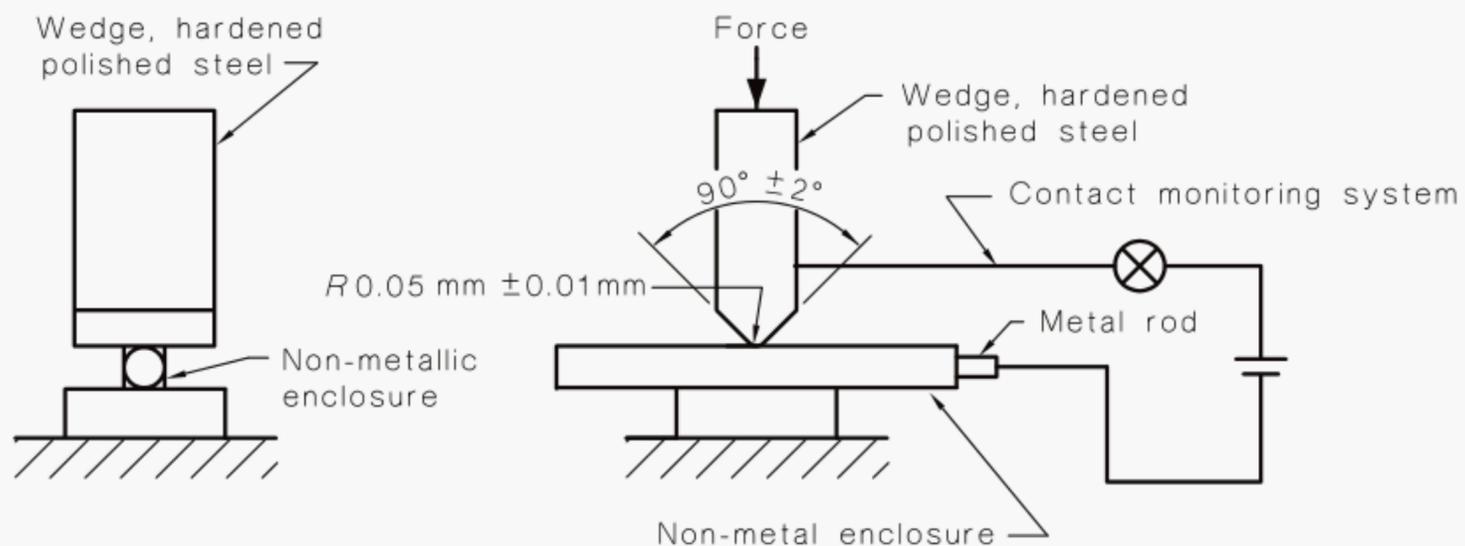


FIGURE E2 CUTTING TEST ARRANGEMENT
(Non-metallic enclosures)

E6 PROCEDURE

The procedure shall be as follows:

- Set the indenter to move with a velocity of 50 ± 1 mm/min. The loading force shall be measured throughout the test.
- Remove the specimen from the conditioning chamber and locate in the test apparatus. Flat cables shall be tested across both the minor and major axis. Simple retaining methods which restrain the specimen from moving are acceptable.
- Connect the contact monitoring system. The cutting wedge, all cable screens, drain wire, armour, and braid, are connected to one pole of the voltage source. All other cable metallic parts, or metallic metal inserts, shall be connected to the opposite pole of the voltage source.
- Commencing within 60 s and finishing within 300 s of the removal of the specimen from the conditioning chamber perform the test at four locations 50 ± 5 mm apart. Rotate the specimen 90° (clockwise as viewed from one end only) about its axis each time.

- (e) Halt the test when the load specified in Column 3 of Table 3.2 for a given classification is achieved or failure is detected before the specified load is achieved.

E7 TEST CRITERIA

A specimen is deemed to have passed when the specimen has been exposed to the level of cutting force specified in Table 3.2 without failure.

A specimen shall be considered to have failed when, at any of the four test locations, at a load less than the load specified in Table 3.2 for a given classification, the wedge—

- (c) for cables, makes contact with a conductor, as indicated by the contact monitoring system; or
- (d) for non-metallic enclosures, makes contact with the metallic insert, as indicated by the contact monitoring system.

E8 REPORTING OF RESULTS

The test report shall include—

- (a) sufficient detail to uniquely identify each specimen under test;
- (b) the temperature at which the specimen was conditioned;
- (c) the resultant cable or enclosure cutting test classification; and
- (d) in the event of a test failure, the test report shall include—
 - (i) sufficient details to uniquely identify the specimen tested;
 - (ii) the recorded load in Kilonewtons at failure.

E9 RETENTION OF SPECIMENS

A specimen, sufficient to uniquely identify the sample, shall be retained by the testing authority, whether the sample has met the criteria of the submitter or has failed.

E10 RETESTING OF SAMPLES

In the event of a failure, the test may be repeated on two identical specimens in the same configuration and mounting. If both these specimens pass the test then the cable or enclosure shall be deemed to have passed. If either of these repeat test specimens fails the test, then the sample is deemed to have failed.

At the discretion of the submitter, the cable, busway, or enclosure shall be deemed to have failed, either after a test failure (Paragraph E7) or after a failure during re-testing (this Paragraph E10).

Once deemed to have failed, the submitter shall not re-submit the same cable, busway, or enclosure for test, unless a significant change is made to the cable, busway, or enclosure. Examples of 'significant change' for cables or busways are any of those listed in Paragraph A4, which are deemed to require a separate qualification.

E11 CLASSIFICATION

E11.1 Cables

For any cable tested, the same cutting classification may be deemed to apply to any cable of the same construction comprising—

- (a) more conductors with the same cross-sectional area; or
- (b) larger conductors with the same number of cores.

E11.2 Enclosures

For any enclosure tested the same cutting test classification shall be deemed to apply to any enclosure of the same construction as that tested providing that the wall thickness of the material is equal or greater than that tested.

APPENDIX F
GUIDE TO USE OF THE CLASSIFICATION SYSTEM
(Informative)

F1 APPLICATION

The Building Code of Australia, installation codes and reference standards will nominate the classification for particular applications.

This Appendix provides advice and detailed examples and alternatives to those applications, that result in compliant installations.

F2 FIRE PROTECTED WIRING SYSTEMS

A wiring system can be provided with protection against fire conditions in three ways:

- (a) The use of wiring systems classified in accordance with this Standard and not depending on fire-rated elements of building construction for thermal protection.
- (b) The use of wiring systems not classified in accordance with this Standard and depending on fire-rated elements of building construction for thermal protection.
- (c) The use of wiring systems classified in accordance with this Standard but depending upon fire-rated elements of building construction to provide thermal protection to comply with the requirements of the installation Codes or Standards.

F3 MECHANICALLY PROTECTED WIRING SYSTEMS

F3.1 General

A wiring system can be provided with protection against mechanical damage by—

- (a) the use of wiring system elements having the required mechanical rating determined in accordance with this Standard; or
- (b) the use of a wiring system element rated in accordance with this Standard and provided with additional mechanical protection.

F3.2 Unenclosed wiring systems

For unenclosed wiring systems, cables and busways providing inherent mechanical protection and rated to the requirements of this Standard should be selected. They should be routed via a pathway using impact resistant building structure elements and supported where necessary by appropriate impact resistant hardware and fixings. All components used in such wiring systems should be tested to be in accordance with the appropriate requirements of this Standard.

F3.3 Enclosed wiring systems

If mechanical protection of the cable(s) or busway(s) is achieved by an additional enclosure, the protection may be in the form of—

- (i) a complete enclosure such as a conduit, pipe, trunking or other housing; or
- (ii) a barrier which is interposed between the cable(s) or busway(s) and the possible source of mechanical damage.

In both cases, the additional protection must be capable of resisting the mechanical damage.

F4 GUIDE TO MECHANICAL PROTECTION CLASSIFICATION

To achieve a WS classification a wiring system must be tested in accordance with this Standard, however the following systems will generally provide the mechanical protection required for the classification under which they are listed:

- (a) *WSX1 protection systems* Provide protection against light impact as follows:
- (i) Wiring systems meeting the requirements of this Standard.
 - (ii) One sheathed cable immediately adjacent to a projecting timber batten or similar corner so that the projection is not less than twice the dimension of the cable in that direction. See Figure F1.
 - (iii) Light or medium duty conduits complying with [AS/NZS 2053](#).
 - (iv) Metallic trunking with clip-on covers.
 - (v) Non-metallic trunking with clip-on covers.
- (b) *WSX2 mechanical protection systems* Provide protection against moderate impact as follows:
- (i) Wiring systems meeting the requirements of this Standard.
 - (ii) Heavy duty conduits complying with [AS/NZS 2053](#).
 - (iii) Armoured cables, e.g. those complying with [AS/NZS 5000.1](#).
 - (iv) Metallic trunking with a minimum metal thickness of not less than 1.6 mm, a screw fixed lid and not exceeding 100 mm in width.
 - (v) Fabricated steel cover with metal not less than 1.6 mm thick, and un-reinforced width not exceeding 100 mm.
 - (vi) Any WSX1 system with a cover of 10 mm of plaster or concrete.
 - (vii) MIMS cables complying with [AS/NZS 3187](#).
- (c) *WSX3 mechanical protection systems* Provide protection against heavy impact as follows:
- (i) Wiring systems meeting the requirements of this Standard.
 - (ii) Any wiring system with additional 2.0 mm thick sheet steel coverage with an unsupported width not exceeding 100 mm.
 - (iii) Any WSX2 system with an additional 1.6 mm thick sheet steel coverage with an unsupported width not exceeding 100 mm.
 - (iv) Galvanized medium tube to [AS 1074](#).
 - (v) Very heavy duty conduits complying with [AS/NZS 2053](#).

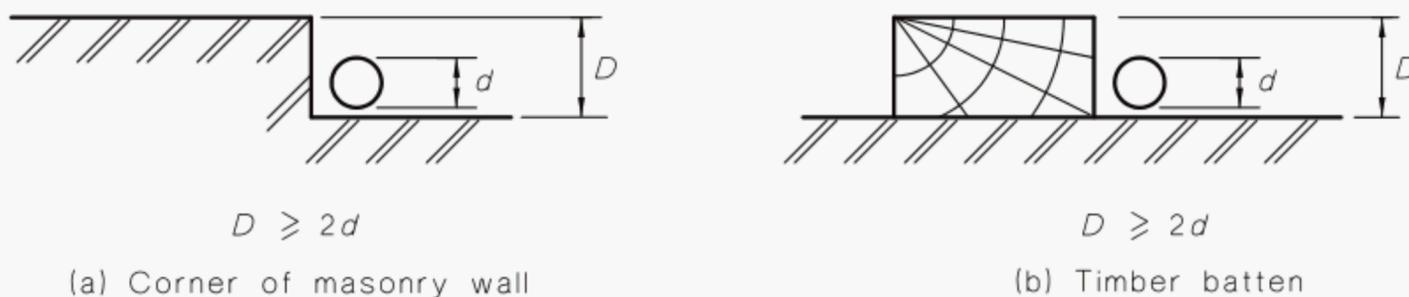


FIGURE F1 EXAMPLES OF WSX1 PROTECTION BY LOCATION

NOTES

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 a Memorandum of Understanding 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).

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