

Equipment Technical Specification

Distribution fuses

IMPORTANT DISCLAIMER

As the information contained in this publication is subject to change from time to time, Endeavour Energy gives no warranty that the information is correct or complete or is a definitive statement of procedures. Endeavour Energy reserves the right to vary the content of this publication as and when required. You should make independent inquiries to satisfy yourself as to correctness and currency of the content. Endeavour Energy expressly disclaims all and any liability to any persons whatsoever in respect of anything done or not done by any such person in reliance, whether in whole or in part, on this document.

Copyright © Endeavour Energy 2016

Equipment Technical Specification

ASSET STANDARDS AND DESIGN

Document No	:	ETS 0071
Amendment No	:	1
Approved By	:	GMAM
Approval Date	:	03/05/16
Review Date	:	03/05/21

ETS 0071 DISTRIBUTION FUSES

CONTENTS

1.0	PURPOSE.....	4
2.0	SCOPE	4
3.0	REFERENCES.....	4
4.0	DEFINITIONS AND ABBREVIATIONS.....	5
5.0	ACTIONS.....	7
5.1	General	7
5.1.1	<i>General.....</i>	7
5.1.2	<i>Service conditions and environment</i>	8
5.2	Padmount and indoor substation fuses.....	8
5.2.1	<i>High Voltage fuse for padmount and indoor substations</i>	8
5.2.2	<i>Low voltage fuses for padmount and indoor substations.....</i>	9
5.2.3	<i>Solid blade links.....</i>	10
5.2.4	<i>J type fuse links - spare fuses for existing installations</i>	10
5.3	Pole substation fuses.....	11
5.3.1	<i>Dropout fuses for pole substations and overhead HV distribution lines</i>	11
5.3.2	<i>Low voltage fuse for pole substations</i>	12
5.4	Testing.....	14
5.4.1	<i>General.....</i>	14
5.4.2	<i>Testing laboratories</i>	15
5.4.3	<i>Type tests.....</i>	15
5.4.4	<i>Routine tests.....</i>	15
5.4.5	<i>Thermocouple locations.....</i>	15
5.4.6	<i>List of type tests.....</i>	15
5.5	Quality assurance.....	16
5.6	Approval process	16
5.6.1	<i>Product approval and audit form:.....</i>	16
5.7	Drawings	16

6.0 AUTHORITIES AND RESPONSIBILITIES.....16

7.0 DOCUMENT CONTROL 17

1.0 PURPOSE

To set out in detail the minimum requirements for the design manufacture and testing of fuses suitable for use in Endeavour Energy distribution network.

2.0 SCOPE

This specification covers the requirements, types, classifications and mechanical arrangements for fuses to be used in Endeavour Energy's distribution network. These fuses are used with switchgear installed in indoor substations, padmount substations, pole mount substations and mains pillars.

It is not the intention to specify the manufacturing, testing and material requirements in detail. However, the fuses offered in response to this specification shall be manufactured and tested to the standards with the year of publication listed below.

This specification does not cover the procedure for selection of fuses for Endeavour Energy applications. Endeavour Energy procedures for the selection of fuses for different applications are set out in MCI 0005 and MCI 0006.

This document does not cover the specification of the equipment on which the fuses are mounted, such as switchgear, dropout fuse assemblies and fuse bases.

3.0 REFERENCES

Internal

- Company Policy 9.2.2 (Network) – Network Protection
- Company Policy 9.2.5 (Network) – Network Asset Design
- Company Policy 9.7.1 (Network) – Network Construction
- Company Policy 9.8.3 (Network) – Network Operations
- Branch form PAE 1004 - Product approval process
- Branch form FAE 3161 - Distribution fuses approval and audit form
- Equipment Technical Specification ETS 0068 - Distribution indoor and padmount substation 12-24kV switchgear
- Equipment Technical Specification ETS 0069 - Distribution indoor and padmount substation low voltage switchgear
- Mains Construction Instruction MCI 0005 - Overhead distribution construction standards manual
- Mains Construction Instruction MCI 0006-Underground distribution construction standard manual
- Equipment Technical Specification ETS 0083 – 12kV/24kV expulsion dropout fuse specification

External

- Code of Practice-Distribution Risk Management-NSW Department of Energy, Utilities and Sustainability (DEUS) 1998
- ENA-National Electricity Network Safety Code (NENS 01-2008)
- AS 3000: – SAA Wiring Rules Oct 2007
- AS 1033.1:1990 - High voltage fuses (for rated voltages exceeding 1000V)-Expulsion Type (including boric acid fuses)—Similar to IEC 60282-2:2008
- AS 1033.2:1988 - High voltage fuses (for rated voltages exceeding 1000V)-Current Limiting (Powder filled Type)-- Similar to IEC 60282-1:2014
- AS/NZS IEC 60947.1:2015 – Low-voltage switchgear and controlgear Part 1: General rules
- AS 62271.1:2012 – High-voltage switchgear and controlgear. Part 1: Common specifications

- IEC 60269.1:2014 – Low-voltage fuses Part 1: General Requirements
- IEC 60269.2:2014 – Low-voltage fuses Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardised systems of fuses A to K
- IEC 60269.3:2014 – Low-voltage fuses Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar application) – Examples of standardised systems of fuses A to F

4.0 DEFINITIONS AND ABBREVIATIONS

Current limiting fuse

Device that during and by its operation in a specified current range, limits the current to a substantially lower value than the peak value of the prospective current.

General purpose fuse (G)

Current limiting fuse capable of breaking, under specified conditions of use and behaviour, all currents from the rated breaking current down to the current that cause melting of the fuse-element in one (1) hour.

Back-up fuse

Current limiting fuse capable of breaking, under special conditions of use and behaviour, all current from the rated breaking current down to the rated minimum breaking current. Backup fuses are generally associated with another switching device.

Full-Range fuse

Current-limiting fuse capable of breaking, under specified conditions of use and behaviour, all currents that cause melting of the fuse element(s), up to its rated maximum breaking current.

Distribution fuse

Switching device, used at voltages of 22 kV or less, that by the fusion of its element disconnects the circuit in which it is installed. Fuses with voltage rating to 1000Vac. and 1500 Vdc are known as low voltage fuses. Fuses with voltage ratings exceeding 1000 Vac are known as high voltage fuses.

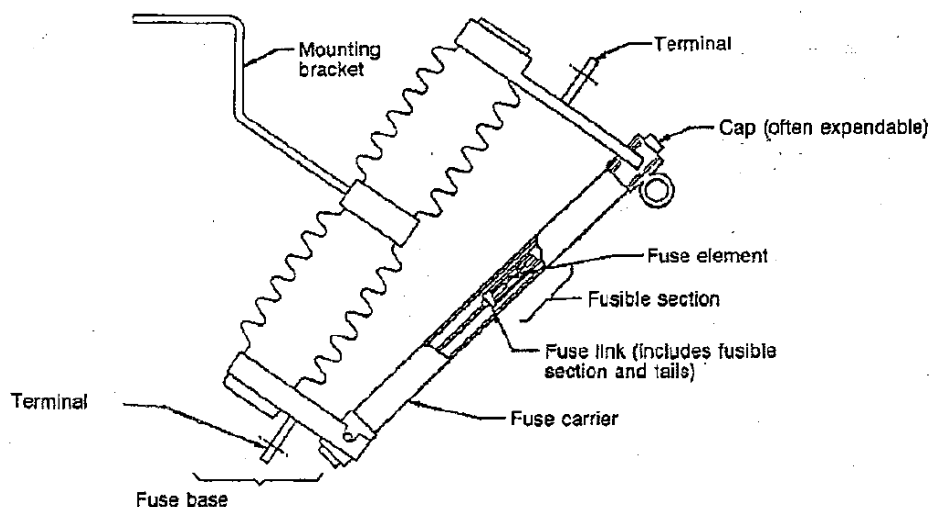
Dropout fuse or expulsion dropout fuse

A fuse which, when it operates, causes the fuse-carrier to drop to an open position that provides a visible indication that it has operated. Expulsion fuses are fuses in which the arc is extinguished by the expulsion effect of the gases produced by the arc.

Dropout fuse components

Fuses are composed of the following parts:

Figure 1: Dropout fuse



Dropout fuse-base

Fuse-mount -the part of a fuse containing fixed contacts and terminals on an insulated base.

Dropout fuse-carrier

The part of a fuse designed to hold the fuse-link. It contains contacts intended to engage with the fuse-base contacts such that the carrier may be removed from the base.

Dropout fuse-link

The part of a fuse containing the fuse-element. The fuse-link must be replaced by a new fuse-link after the operation of a fuse.

ENA

Energy Networks Association

ETS

Equipment Technical Specification

Fuse-element

The part of a fuse designed to melt when the current exceeds a given value for a sufficient time.

HRC

high rupturing capacity current limiting fuse

Indicator

Device designed to provide indication that a fuse has operated.

LV

Low voltage

MEN

Multiple Earthed Neutral

MCI

Mains Construction Instructions

MDI

Mains Design Instruction

NATA

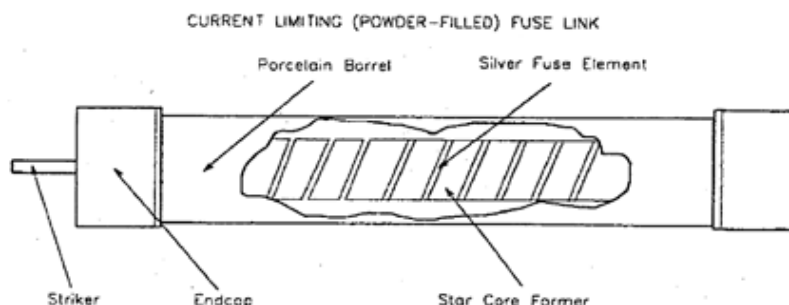
National Association of Testing Authorities

SDI

Substation Design Instructions

Striker

Mechanical device that travels at a specified force and travels during the fuse operation. It may be used as an indicator or to provide initiation to a tripping device.

Figure 2: Current limiting (powder-filled) fuse link with striker pin**SWER**

Single Wire Earth Return

TCC

Time current curve

TRV

Transient recovery voltage

5.0 ACTIONS**5.1 General****5.1.1 General**

The fuses shall comply with the specified standards and be suitable for use in the Endeavour Energy distribution network.

All ferrous parts shall be treated to provide acceptable surface finish and protection from corrosion.

All component parts shall be supplied and tested in accordance with the specified standard. The equipment shall include everything necessary or usually supplied for operation, whether directly specified or not.

The manufacturer is required to provide all information requested in the FAE 3161 form and attach specified test reports, time/current characteristics and the like where specified.

5.1.2 Service conditions and environment

Endeavour Energy's LV network consists mainly of nominal 400V three- (3) phase system with an extensive MEN system (TN-C-S earthing system).

The Endeavour Energy distribution network consists of 11kV distribution substations and 22kV distribution substations. The number of 22kV substations is approximately 5% of the total substations.

The equipment shall be suitable for use on Endeavour Energy's 11kV and 22kV 3-phase 50Hz system having the neutral point of the supply source effectively earthed. The highest continuous system voltages are 12kV and 24kV RMS respectively.

Except for the LV fuses used for padmount and indoor substations, the service condition for all other fuses are in accordance with the requirements of normal service conditions set out in clause 2.1 of AS 62271.1:2012.

Free-standing cubicles used for padmount substations are subjected to high levels of humidity and temperature. Some padmount substations are located in a dusty and/or moist environment. The air temperature inside the padmount substation cubicle may reach 80 deg. C which is a much higher value than the highest ambient air temperature stated in clause 2.1 of AS 62271.1:2012. This high temperature within the confined space of padmount substation is due to transformer losses, the effects of solar radiation and heat contribution from the switchgear. Padmount substation cubicles are not provided with forced ventilation. The fuses shall be suitable for use in this type of environment, Endeavour Energy will provide some adjustments to the ratings accordingly.

5.2 Padmount and indoor substation fuses

5.2.1 High Voltage fuse for padmount and indoor substations

Table 1 sets out the approved sizes of medium voltage fuses to be used with the switchgear installed in padmount and indoor substations. In deciding the fuse sizes, consideration has been given to the transformer capacity and grading with low voltage fuses and circuit breakers.

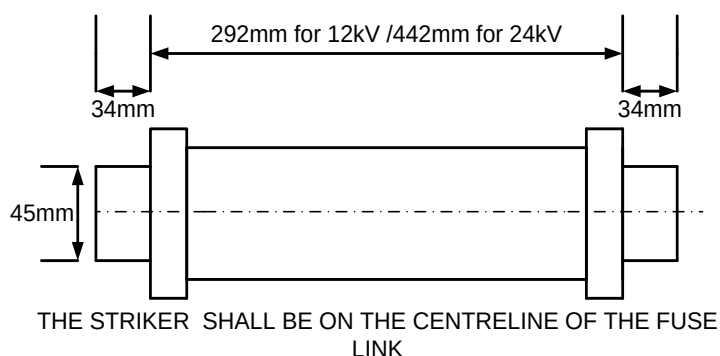
Table 1: Approved high voltage fuse sizes for padmount and indoor substations

12kV HRC Fuses	50A	63A	100A
24kV HRC Fuses	25A	32A	50A

The 12kV and 24kV current limiting fuse links shall be either back-up or full range, Type I, as in Appendix D of AS 1033.2:1988 with the dimensions given in Figure 3, and striker type medium.

The fuse links must be suitable for use in Endeavour Energy substations and shall comply with AS 1033.2:1988. Fuses of 12kV with extenders are acceptable to use with 24kV switchgear when 24kV switchgear is used for 12kV application.

Figure 3: Type I fuse links



Fuses used in new switchgear and in most existing switchgear installations are incorporated with an active striker pin mechanism. Operation of the striker pin in any fuse switch combination unit shall disconnect all three phases simultaneously.

Table 2: Maximum in- service temperatures for HV fuse contacts – refer to Table 3 of AS 62271.1:2012

Contacts	Maximum Temperature deg. C	Maximum temperature rise at ambient air temperature not exceeding 40 deg. C K
i) Bare copper	75	35
ii) Tin-coated copper	90	50
iii) Silver or nickel-coated copper	105	65

5.2.2 Low voltage fuses for padmount and indoor substations

Table 3 below sets out the approved sizes of low voltage fuses to be used with the various category of switchgear used in padmount and indoor substations. In deciding the sizes, consideration has been given to the transformer capacity, downstream fuses and circuit breakers.

Table 3: Approved LV blade contact fuse sizes for padmount and indoor substations

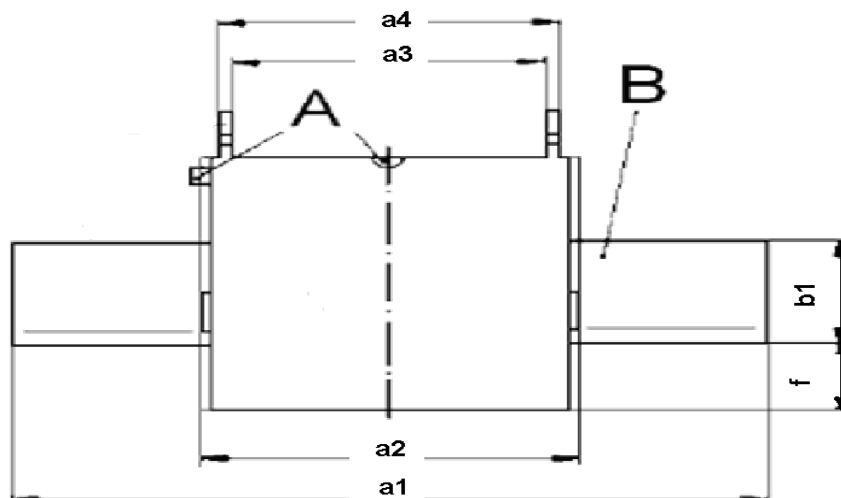
Blade contact (DIN) fuse for LV switchgear	250A	315A	400A
--	------	------	------

Fuses shall be blade contact (called DIN fuses) size 2, as shown in figure 101 of IEC 60269-2:2013. The utilisation category is gG (g-full range braking capacity, G-general application), rated voltage 500V ac, maximum rated current 400 Amp, maximum rated power dissipation 34W, and dead pin.

The fuse links must be suitable for use in Endeavour Energy substations and shall comply with IEC 60269.2:2013. The maximum in-service temperatures of the contacts specified in Table 5 must be met.

Details of the fuse links are shown in Figure 4 and the dimensions are set out in Table 4.

Figure 4: Fuse links with blade contacts from Figure 101 of IEC 60269.2:2013



A Indicating device

B Contact

Table 4: Dimensions of blade contact fuses with maximum rated current 400A and voltage 500V-refer figure 101 of IEC 60269-2:2013 for remaining dimensions

Size	a1	a2	a3	a4	b1 min	f max
2	150 ±2.5	75 -10	62 ±2.5	68 ±2.5	25	15

Fuse size selection (A); 400, 315, 250,200,160,100,80. (Refer table 2 and table 9)

Table 5: Maximum in-service temperatures for LV fuse contacts – refer to Table 2 of AS/NZS IEC 60947.1:2015

Contacts	Maximum temperature rise from ambient temperature K
Bare copper	60
Bare brass	65
Tin-coated copper	65
Silver or nickel-coated copper	70

(Maximum external ambient temperature = 40 deg C)

5.2.3 Solid blade links

Solid blade links shall have a minimum current rating of 630 Amps and shall be fitted with insulated tags, and be compatible with fuse base size 2 specified in Figure 102 of IEC 60269-2:2013.

5.2.4 J type fuse links - spare fuses for existing installations

J type fuse links are of 400 Vac, 400A maximum rated current with the details shown in figure 5 and the dimensions in Table 6. Except for the dimension variation, J type fuses must comply with gU ("g" braking range and "U" utilisation category) fuse links with wedge tightening contact

specified in Fuse system I of IEC 60269-2:2013. The J type fuse link, size 400A, is approved for use **only** in existing electrical installations.

Figure 5: J type fuse links

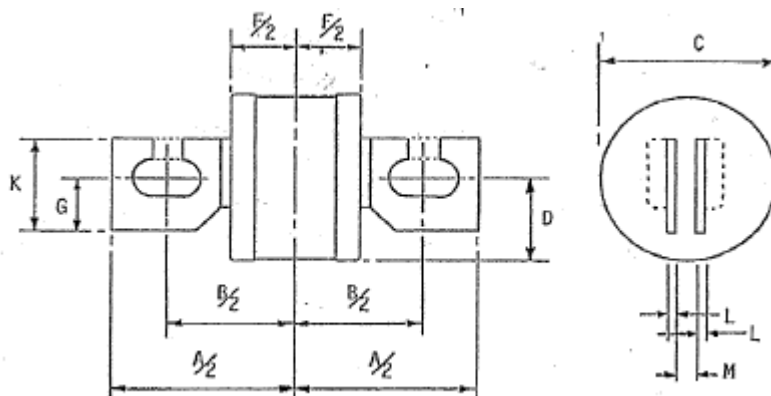


Table 6: Dimensions of J type fuse links

Max rated current A	Max power dissipation W	A (max) mm	B (nom) mm	C (max) mm	D (max) mm	F (max) mm	G (nom) mm	K (nom) mm	L (nom) mm	M (max/min) mm
400	33	112	82	41	18	45	18	31	2.4	6.53 6.45

5.3 Pole substation fuses

5.3.1 Dropout fuses for pole substations and overhead HV distribution lines

Table 7 sets out the approved sizes of fuse links for dropout fuse assemblies. In deciding the fuse sizes consideration has been given to the transformer sizes and grading with LV fuses and circuit breakers.

Table 7: Approved dropout fuse sizes for pole substations and HV distribution lines

Expulsion dropout fuses for 12kV (maximum 8kA fault level)	3.15A	8A	16A	20A	40A	63A	80A	100A
Powder filled fuses(boric acid) 24kV (maximum 16.8kA fault level)	3A	8A	16A	20A	40A	N/A	N/A	N/A

The boric acid fuses specified above are used in the following situations in the 11kV system:

- Adjacent to zone substations where the fault level exceeds 8kA value.
- Low fault level and high soil resistivity locations generally with transformers up to 50kVA.

The fuse links must be suitable for use in the Endeavour Energy distribution network and shall comply with AS 1033.1:1990.

Fire chokes are not to be fitted with dropout fuses.

The expulsion dropout fuse links must be spark class A, speed of operation Class K, and TRV capability Class 1, as set out in section 3.1 of AS 1033-1:1990.

5.3.2 Low voltage fuse for pole substations

Table 10 sets out the approved sizes of low voltage fuses for different types of switchgear used in pole substations. In deciding the fuse sizes, consideration has been given to transformer capacity, downstream capacity, grading and sensitivity.

5.3.2.1 Cylindrical fuse links (service fuses or barrel fuses)

Cylindrical fuse links must be suitable for use with a typical fuse carrier and base shown in figure 301 of IEC 60269-3:2013. The service fuse sizes 22mm and 30mm given in Table 8 must be suitable for outdoor use and shall comply with the referred standards.

Figure 6: Service fuse size IIa (22mm) and IIb (30mm) - refer to Figure 301 of IEC 60269-3:2013

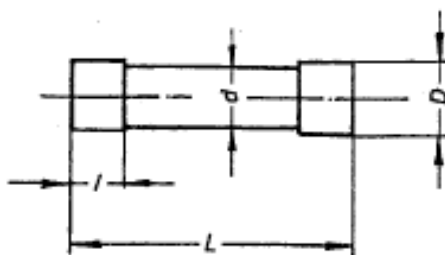


Table 8: Details of cylindrical fuse –links to comply with IEC 60269-3:2013

Size	Maximum rated current (A)	Fuse size selection (A)	Maximum power dissipation (W)	(L) Length (mm)	(I) Length of endcap (mm)	(D) Diameter of endcap (mm)
IIa	63	63	5.0	57±1.0	16±0.5	22.23±0.1
	80	80	6.0	57±1.0	16±0.5	22.23±0.1
IIb	100	100,80,63	6.0	57±1.0	16±0.5	30.16±0.1

5.3.2.2 Bolted fuse links

Bolted type fuse links must be size B as stated in Figure 501 of IEC 60269-2:2013, utilisation category gG (g-full range braking capacity, G-general application), 400Vac maximum rated current 400 Amp with maximum power dissipation 40W with the dimensions stated in Table 9.

Bolted fuse links must be suitable to use with outdoor crossarm mounted LV Line Isolating switch fuse (crossarm mount) assembly and shall comply with IEC 60269-2:2013.

Figure 7: Bolted fuse links size B (refer to Figure 501 of IEC 60269-2:2013)

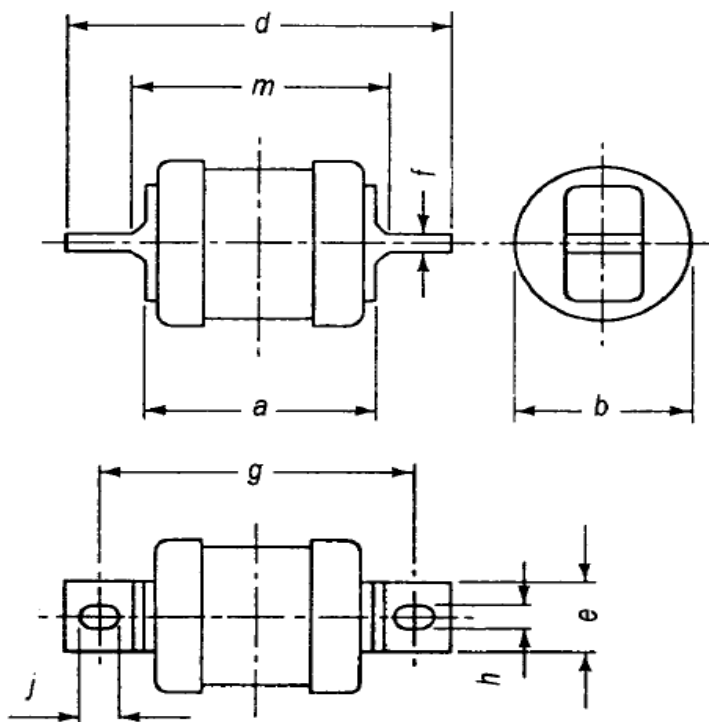


Table 9: Dimensions of bolted fuse links

Size	Max rated current A	Fuse size selection A	Max power dissipation W	a (max) mm	b (max) mm	d (max) mm	e (max) mm	f (max) mm	g (max) mm	h (nom) mm	j (min) mm	m (max) mm
B1	100	100,80	9.1	70	37	138	20	4	111	8.7	11	82
B2	200	200,160	17	77	42	138	20	4	111	8.7	11	82
B3	315	315,250	32	77	61	138	26	4.8	111	8.7	11	82
B4	400	400	40	83	66	138	26	6.6	111	8.7	11	89

5.3.2.3 Bolted solid links

Bolted solid links shall have a minimum current rating of 600A, and are suitable for use with crossarm mount LV isolating switches. The solid links must be compatible with size B fuses specified in IEC 60269-2:2013.

5.3.2.4 Blade contact fuse links (DIN fuses)

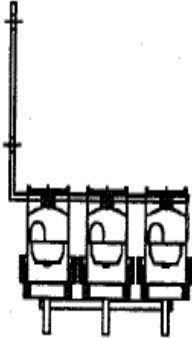
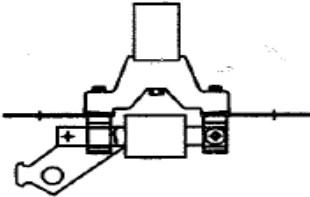
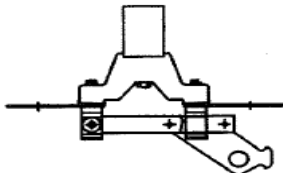
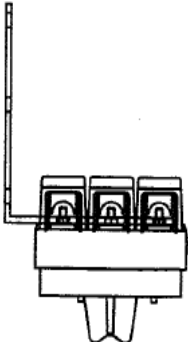
Blade contact size 2 fuses are also used in padmount and indoor substations. Specifications for the fuse links are provided in clause 5.2.2. The fuse links must be suitable for use with outdoor pole mounted LV ABC switches. Refer Table 10 for approved sizes.

5.3.2.5 Blade contact solid links

Blade contact solid links are specified in clause 5.2.4. The blade contact solid links must be suitable for use with outdoor pole mounted LV ABC switches.

Table 10: Approved LV fuse categories and sizes for pole substations (outdoor use)

Fuse category	Fuse size (Amp)	Used with
Cylindrical fuse links (service fuse) 22mm	63	Fuse holder-pole mount - two (2) sizes to fit either 22mm or 30mm fuse links

Fuse category	Fuse size (Amp)	Used with
dia. (refer Figure 6 and Table 8)	80	
Cylindrical fuse links (service fuse) 30mm dia. (refer Figure 6 and Table 7)	63	
	80	
	100	
Bolted, type B (refer Figure 7 and Table 9)	80	LV line isolating switch fuse - crossarm mount 
	100	
	160	
	200	
	250	
	315	
	400	
	600 (solid link)	LV line isolating switch solid links - crossarm mount 
Blade (DIN) fuse type 02 (refer Figure 4 and Table 4)	80	ABC switch - pole mount 

5.4 Testing

5.4.1 General

The manufacturer **must** provide two (2) copies of certified test reports for all type, routine and special tests that are applied, to respective standard, to the various components during and on completion of manufacture. Depending on the tests that are specified in relevant standards, Endeavour Energy may require additional tests to be conducted.

At any time during the supply of the equipment, Endeavour Energy may consider it necessary to confirm any test results. These tests will initially be carried out at Endeavour Energy's expense, however, where it can be demonstrated that the equipment does not meet with the provided test results, tests will be repeated in the presence of a supplier's representative. This and subsequent tests will be at the supplier's expense.

Depending on the extent of these non-conformances, Endeavour Energy may remove or rectify equipment already in service. In these cases, all costs will be at the supplier's expense.

5.4.2 Testing laboratories

The technical schedules and guarantees (together with a copy of each of the tests) shall be completed and submitted to Endeavour Energy for evaluation.

All type tests shall be carried out by a testing authority holding accreditation:

- by NATA Australia; or,
- by an accreditation authority recognised by NATA Australia.

Tests from other testing authorities may be accepted at the discretion of the Manager Asset Standards & Design

5.4.3 Type tests

Type tests to be conducted upon completion of the design, or following a change that affects the performance. Required type tests for each category of fuses are listed in clause 5.4.6.

5.4.4 Routine tests

Routine tests will not usually be required; however it is the manufacturer's responsibility to confirm that all fuses supplied consistently meet the requirements of the relevant standards and this specification.

5.4.5 Thermocouple locations

Where relevant, the thermocouple positions shall be:

- All fuse contacts.
- All fuse tags.
- All accessible switch contacts.
- All cable termination palms.
- All external bolted connections (including transformer terminations).

With prior approval, thermocouples can be restricted to the switchgear components where the temperature rise is expected to be most critical.

5.4.6 List of type tests

5.4.6.1 List of type tests for LV fuses

All tests specified are set out in clause 8.1.1 of IEC 60269-1:2014. The tests listed are the minimum required.

General tests (to IEC 60269-1:2014)

- Dimensions to comply with clause 8.1.4
- Testing of fuse links to comply with clause 8.1.5.1 and as stated in table 7A
- Verification of insulating properties to comply with clause 8.2
- Verification of temperature rise and power dissipation at specified rated voltage and rated current to comply with clause 8.3
- Verification of operation to comply with clause 8.4

Additional tests for blade contact fuses (to IEC 60269-2:2013)

- Impact resistance of gripping lugs to comply with clause 8.11.1.8
- Verification of resistance to heat to comply with clause 8.9

5.4.6.2 List of type tests for HV fuses

Drop out fuses

The minimum tests required (to AS1033.1-1990):

- Tests for time/current characteristics to comply with clause 5.7
- Verification of spark production class (class A required) to comply with clause 3.1.4
- Verification of speed class (class K required) to comply with clause 3.1.3
- Verification of TRV rating (class 1 required) to comply with clause 3.1.2.
- Breaking tests to comply with clause 5.6

If test results are available for verification of breaking capacity for combinations of the manufacturer's element with other manufacturers' carriers, or vice versa, these must be supplied.

An indication should be provided of the suitability of the manufacturer's elements for use with other manufacturers' carriers, or vice versa, along with a statement or guidelines on the mixing of the manufacturer's components with those of other manufacturers.

Powder filled - current limiting fuses

The minimum tests required (to AS 1033.2-1988):

- Dielectric test to comply with clause 4.4
- Temperature rise and power dissipation tests to comply with clause 4.5.
- Breaking tests to comply with clause 4.6
- Tests for time/current characteristics to comply with clause 4.7
- Test of strikers to comply with clause 4.9

5.5 Quality assurance

Quality assurance certification is required to certify the manufacturer's ability to design and consistently manufacture fuses to this specification. The supplier and all its contractors shall have a quality system which complies with the requirements of AS/NZS ISO 9001 or other comparable Australian or International equivalent.

5.6 Approval process

5.6.1 Product approval and audit form:

In addition to all technical data, complete information on items shall be provided on Branch form FAE 3161.

Product approval process:

Endeavour Energy will approve the equipment for use on the network. The product shall be evaluated under the product approval process set out in PAE 1004.

5.7 Drawings

No drawings have been created for this specification.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for:

- approving technical specifications, including any variations;
- making all decisions concerning compliance in respect to this specification;
- approving nominations of Endeavour Energy representative/s; and

- delegating any of these authorities and responsibilities to the Manager Asset Standards & Design.

Manager Asset Standards & Design has the authority and responsibility for:

- reviewing this specification and making recommendations to the General Manager Asset Management;
- making recommendations concerning compliance in respect to this specification; and
- making nominations of Endeavour Energy representative/s.

Network Substations Manager has the authority and responsibility for:

- reviewing all test reports submitted and making recommendations to the Manager Asset Standards & Design; and
- clarifying all technical aspects of this specification to the stakeholders;

Protection Manager has authority and responsibility for reviewing power system protection parameters and making recommendations to Manager Asset Standards & Design.

7.0 DOCUMENT CONTROL

Documentation content coordinator: Network Substations Manager

Documentation process coordinator: Branch Process Coordinator