Equipment Technical Specification

12kV and 24kV expulsion drop-out fuse

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12KV AND 24KV EXPULSION DROP-OUT FUSE

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1.0 PURPOSE

To specify the minimum requirements for selection of 12kV and 24kV expulsion drop-out fuses (EDOF) for use in the company’s overhead distribution network.

2.0 SCOPE

The scope of work consists of the design, engineering, manufacture and testing at the manufacturer’s works and delivery of the 12kV or 24kV expulsion drop-out fuses.

There are two (2) basic designs of EDOF used by the company and they are:

Type 1: The standard unit used on the 12kV network with low fault levels (tinned copper element design).

Type 2: Used on high fault level 12kV areas and on all 22kV (incl. SWER) areas (boric acid design: power fuse).

It is not the intention to specify the manufacturing, testing and material requirements in detail. However, the EDOF must be manufactured to the highest quality standards. The scope includes all items that are necessary for the operation of the equipment, whether specified or not and includes all mounting, earthing, operating and locking facilities specified in this document.

All supplied EDOFs and associated equipment must be manufactured and tested to the standards with the year of publication listed in section 3.0 below. In some circumstances based on local network conditions and experience, this specification is more stringent or is inclusive of requirement not covered in Australian and International Standards; in this circumstance the requirements of this specification must take precedence.

Tenderers must state any non-compliance with the specification in any tender submission and any alternative offers must be submitted in full and separately from any main offer. Any proposed variations from this specification must be referred to Substation Assets Manager for approval prior to acceptance.

3.0 REFERENCES

Internal
Company Policy (Network) 9.2.5 – Network Asset Design
Company Policy (Network) 9.2.10 – Network Asset Ratings
Company Policy (Network) 9.7.1 – Network Asset Construction
Company Policy (Network) 9.8.3 – Network Operations
Company Policy (Network) 9.9.1 – Network Asset Maintenance
Branch Procedure (System Control) NCB 4187 - Operation of 11kV/22kV Air Break Switches, Underslung Links and Drop-Out Fuses.
Branch Procedure (System Control) NCB 4195 – Operating Apparatus Subject To Ferroresonance
Branch Procedure (Asset Standards & Design) PAE 1004 – Product approval process
Branch Form (Asset Standards & Design) FAE 3087 – Expulsion drop-out fuse assemblies approval and audit form
Equipment Technical Specification ETS 0071 – Distribution fuses
Mains Construction Instruction MCI 0005 – Overhead distribution construction standards manual
Mains Design Instruction MDI 0031 – Overhead distribution: Design standards manual
Protection Design Instruction PDI 4004 – Protection of distribution mains
Substation Design Instruction SDI 100 – Distribution earthing design, construct & test
Substation Design Instruction SDI 101 – Distribution substation general details and minimum requirements
Substation Maintenance Instruction SMI 101 – Minimum requirements for maintenance of distribution equipment
Company Network Management Plan December - 2013 Review
Network Management Plan - 2009-2014

External

Electricity Supply Act 1995 (NSW)
Occupational Health and Safety Act 2000
Work Health and Safety Act 2011 (NSW)
Electricity Supply (General) Regulation 2014 (NSW)
Work Health and Safety Regulation 2011 (NSW)
ENA National Electricity Network Safety Code (Doc 01-2008)
National Electricity (NSW) Law 1997
National Electricity Rules
AS 1033.1:1990 High voltage fuses (for rated voltages exceeding 1000V) Part 1: Expulsion type
AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Performance, material, general requirements and dimensions
AS 1768:2007 Lightning protection
AS 2067:2016 Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV
AS 2700:2011 Colour standards for general purposes
AS 2947.1:1999 (R2016) Insulators - Porcelain and glass for overhead power lines - Voltages greater than 1000 V a.c. - Test methods - Insulator units
AS 4436:1996(R2016) Guide for the selection of insulators in respect of polluted conditions
AS 4680:2006 Hot- dipped galvanized (zinc) coatings on fabricated ferrous articles
AS 62217:2007 Polymeric insulators for indoor and outdoor use with a nominal voltage > 1000 V – AS 62271.1-2012 - High voltage switchgear and control gear – common requirements
AS ISO 1000:1998 The international system of units (SI) and its application
AS/NZS 2344:2016 Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 to 1000 MHz
AS/NZS 4673:2001 Cold-formed stainless steel structures
IEC 60071-2 Ed. 3.0 (English 1996) Insulation co-ordination - Part 2: Application guide
IEC 60282-2 High-voltage fuses – Part 2: Expulsion fuses

4.0 DEFINITIONS AND ABBREVIATIONS

AC
Alternating current

Company
Endeavour Energy

Distribution network
The collection of assets (distribution lines, cables, substations and associated equipment) whose purpose is to distribute power from a zone substation to distribution substations, which feed the LV network.

Drawings
Drawings must also include any drawings referenced to by that drawing or any drawing referenced to by a referenced drawing.
EDOF
Expulsion drop-out fuse (Tinned copper element and Boric acid type)

MSDS
Material Safety Data Sheet

NATA
National Association of Testing Authorities

Padmount substation
An electrical substation housed in an outdoor enclosure that is designed to prevent the ingress of moisture from rain and storms but is subject to water rise at ground level and high levels of humidity. The enclosure can be made from fibreglass or stainless steel.

RMS
Root mean square

TRV
Transient recovery voltage

5.0 ACTIONS

5.1 Service conditions

5.1.1 General

EDOFs are used throughout the company’s network to manage the protection of network equipment during overloads and fault conditions to maintain a reliable network.

All EDOFs must be suitable for use on the company’s 12kV and 24kV 3-phase 50Hz system. The neutral point of the 11kV and 22kV system is effectively solidly earthed.

However, for some distribution areas in the company’s network, the neutral point is impedance earthed. In such cases, the phase voltage of the healthy phases under fault conditions can rise above normal values, refer to clause 5.3-Technical requirements. The switch insulation must be designed accordingly.

The EDOFs supplied must conform to all the current requirements of the relevant Australian and IEC Standards and this specification.

The equipment supplied must meet the highest standards of engineering, design and manufacturing practices.

The supplier must provide everything necessary, including any special tools, usually supplied for the safe operation of the equipment, whether directly specified or not.

The design and construction must be in accordance with the technical requirements stated.

All materials must be of a type and quality that will give a normal life expectancy of 45 years without deterioration. All ferrous parts must be treated to provide acceptable surface finish and protection. The manufacturer must provide full details of the surface finish provided.

The manufacturer must provide details of the recommended maintenance procedures for the equipment.
**Note:** All values submitted to tender and in Product Approval Forms must be guaranteed values and will be treated as such in the evaluation, and when assessing whether the delivered equipment meets the specification.

### 5.1.2 Service conditions

All ratings and equipment must be suitable for the environment detailed in this document.

**Table 1: Service conditions**

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal service condition</td>
<td>Outdoor to AS62271.1</td>
</tr>
<tr>
<td>Altitude</td>
<td>&lt;1000m *</td>
</tr>
<tr>
<td>Maximum ambient temperature</td>
<td>45 deg. C</td>
</tr>
<tr>
<td>Minimum ambient temperature</td>
<td>-10 deg. C</td>
</tr>
<tr>
<td>Average index of mean relative humidity: 9:00am</td>
<td>95%</td>
</tr>
<tr>
<td>Seismic acceleration coefficient (maximum)</td>
<td>0.09</td>
</tr>
<tr>
<td>Pollution level</td>
<td>Level IV in accordance with AS4436</td>
</tr>
<tr>
<td>Average annual lighting ground flash density</td>
<td>3 to AS1768</td>
</tr>
</tbody>
</table>

*Note* * - Max altitude is 1200m in a small portion of the network which will be evaluated in accordance with the conditions in AS62271.1

### 5.2 Health, safety and environment (HSE) requirements

#### 5.2.1 Special environmental requirements - toxicology safety

The supplier must provide with any offer, full details, including composition and toxicological information, regarding the health and safety aspects of all the materials offered in their offer or supplied equipment regardless of content.

Recommended procedures must be provided for the safe handling, safe operation and maintenance of products supplied. The means of disposal of the materials must be clearly stated. Material safety data sheets (MSDS) must be provided for materials that are supplied and subject to safety considerations in handling and use.

All equipment, packaging and all other accessories provided must be asbestos free.

The above information is required as part of the offer and will be reviewed as part of any tender process.

#### 5.2.2 Noise levels and radio interference voltage (RIV)

It is necessary that noise levels comply with AS1055.2 Level R1 and the radio interference is less than 2500μV, as specified in AS 62271.1.

#### 5.2.3 Fire hazards

The EDOFs may produce high temperatures during fault operations. The EDOF's and its components must be designed in a manner to reduce the risk of subsequent fire risk.
Therefore the EDOFs must be of a sparkles design and comply with the requirements of Clause 3.1.4 and Appendix B of AS 1033.1.

### 5.3 Technical requirements

#### Table 2: Technical requirements

<table>
<thead>
<tr>
<th>Description</th>
<th>All voltages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable standards</td>
<td>IEC 60282.2 and AS 1033.1</td>
</tr>
<tr>
<td>System earthing</td>
<td>Effective and non-effective earth</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>12/24kV 24kV</td>
</tr>
<tr>
<td>Construction type</td>
<td>Type 1 Tinned copper  Type 2 Boric acid type</td>
</tr>
<tr>
<td>Maximum healthy phase voltage during earth fault (effectively earthed) (kVph-E)</td>
<td>12kV 9.8kV 24kV 19.6kV 19.6kV</td>
</tr>
<tr>
<td>Maximum healthy phase voltage during earth fault (non-effectively earthed) (kVph-E)</td>
<td>- 25.1kV 25.1kV</td>
</tr>
<tr>
<td>Rated current of full assembly-min</td>
<td>100A 100A</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50Hz 50Hz</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage:</td>
<td></td>
</tr>
<tr>
<td>• ph-E (peak)</td>
<td>125kVp 125kVp</td>
</tr>
<tr>
<td>• across the isolating distance (peak)</td>
<td>145kVp 145kVp</td>
</tr>
<tr>
<td>Rated 1 min. power freq. withstand voltage - dry:</td>
<td></td>
</tr>
<tr>
<td>• ph-E (rms)</td>
<td>50kV 50kV</td>
</tr>
<tr>
<td>• across the isolating distance (rms)</td>
<td>60kV 60kV</td>
</tr>
<tr>
<td>Rated 1 min. power freq. withstand voltage - wet:</td>
<td></td>
</tr>
<tr>
<td>• ph-E (rms)</td>
<td>50kV 50kV</td>
</tr>
<tr>
<td>• across the isolating distance (rms)</td>
<td>60kV 60kV</td>
</tr>
<tr>
<td>Rated fault current breaking capacity of assembly at rated voltage- Symmetrical (rms value) with up to 100A fuse and at 50Hz</td>
<td>8kA at 11kV 2kA min at 22kV (8kA preferred) 10kA min</td>
</tr>
<tr>
<td>Rated load breaking current at full volts</td>
<td>To be supplied by manufacturer</td>
</tr>
<tr>
<td>Rated fault current capacity of earth connection</td>
<td>16kA</td>
</tr>
<tr>
<td>Classification of assembly:</td>
<td></td>
</tr>
<tr>
<td>• spark production (to AS1033.1)</td>
<td>A</td>
</tr>
<tr>
<td>• speed of operation</td>
<td>K</td>
</tr>
<tr>
<td>• TRV capability (Class)</td>
<td>1</td>
</tr>
<tr>
<td>Operation</td>
<td>Manual</td>
</tr>
<tr>
<td>Insulators</td>
<td></td>
</tr>
<tr>
<td>• Material</td>
<td>Composite or Cycloaliphatic epoxy resin</td>
</tr>
<tr>
<td>Description</td>
<td>All voltages (refer Cl.5.4.5)</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Dimensions (typical)</td>
<td>In accordance with sketch Cl. 5.4.1</td>
</tr>
<tr>
<td>Colour (to AS2700 - preferred)</td>
<td>smoke blue (T33) or light grey (N35)</td>
</tr>
<tr>
<td>Creepage distance - HV terminal to centre support</td>
<td>31 mm/kV</td>
</tr>
<tr>
<td>Isolating distance - across open terminals</td>
<td>≥ 305mm</td>
</tr>
<tr>
<td>Pollution performance rating to AS 4436</td>
<td>Cat IV</td>
</tr>
</tbody>
</table>

**Fittings (preferred)**

<table>
<thead>
<tr>
<th>Material</th>
<th>Stainless steel-Grade 316</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective coating type and thickness</td>
<td>Galvanized / ≥ 80 microns</td>
</tr>
</tbody>
</table>

**Conductor connections (preferred)**

<table>
<thead>
<tr>
<th>Material</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat palm</td>
<td>To suit A or Cu lug</td>
</tr>
<tr>
<td>Protective coating type and thickness (mm)</td>
<td>Tin electroplated / ≥ 20 microns</td>
</tr>
<tr>
<td>Connection type</td>
<td>Fixed 10mm stainless steel bolt</td>
</tr>
</tbody>
</table>

**Fuse carrier (preferred)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Non-organic, typically fiberglass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact type</td>
<td>Spring-loaded wiping</td>
</tr>
<tr>
<td>Plating (type and thickness) mm</td>
<td>Silver/≥ 10 microns</td>
</tr>
<tr>
<td>Operating method</td>
<td>Manual</td>
</tr>
<tr>
<td>Arc shortening rod fitted</td>
<td>Yes or similar technology</td>
</tr>
</tbody>
</table>

**Fuse link (preferred)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse element material</td>
<td>Tinned copper</td>
<td>Silver</td>
</tr>
<tr>
<td>Arc extinguishing aids</td>
<td>-</td>
<td>Boric acid</td>
</tr>
<tr>
<td>Power dissipation at rated current</td>
<td>To be supplied by manufacturer</td>
<td></td>
</tr>
<tr>
<td>Resistance at ambient temperature with 10% or rated current</td>
<td>To be supplied by manufacturer</td>
<td></td>
</tr>
</tbody>
</table>

**Earth connection (preferred)**

<table>
<thead>
<tr>
<th>Type and size</th>
<th>“J” hook as detailed in Cl. 5.4.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>M16 Stainless steel-Grade 316</td>
</tr>
<tr>
<td>Distance from earth connection to nearest conducting metalwork on opposite side of isolating air gap when link is open (mm)</td>
<td>440mm</td>
</tr>
</tbody>
</table>

**Mounting**

| Mounting angle (to the vertical plane) | 15° - 20° |
### Description

<table>
<thead>
<tr>
<th>Material of mounting plate</th>
<th>Galvanized Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>10mm</td>
</tr>
</tbody>
</table>

The Type 1 EDOF will be used on nominal 12kV and 24kV distribution networks and must be capable of classification AK1, at a minimum 50Hz symmetrical breaking current rating of 8kA on 12kV and a minimum 2kA on 24kV (8kA on 24kV is preferred). It must be applicable over the range of speed class K fuse links from 3.15A up to 100A load rating.

The Type 2 EDOF (Boric acid) will be used on all 24kV networks and also where the fault current exceeds 8kA on the 12kV network. It must be of classification AK1, at a minimum 50Hz symmetrical rating of 10kA and at a voltage of 24kV. It must be applicable over the range of speed class K fuse links from 3A up to 100A load rating.

The manufacturer must nominate the homogeneous series of fuse links for all the above DOF and EDOF and must submit certification test certificates from a test laboratory accredited by NATA or an accreditation that is mutually recognised by NATA.

Other alternate designs of fuse will be considered if they are technically equivalent or better and provide a financial benefit to the company.

### 5.4 Construction requirements

#### 5.4.1 General

The EDOF carriers and bases covered by this specification are for outdoor use, suitable for crossarm mounting. The units must consist of a fuse carrier mounted on a single insulator, with upper and lower contact assemblies, and arranged so that the fuse carrier will automatically drop out of the upper contact when the fuse element ruptures.

The equipment must comply in all respects, unless otherwise specified, with IEC 60282.2 and the requirements of this specification.

Each EDOF assembly must be complete with mounting bracket and bolts to suit crossarms ranging from 100mm x 100mm to 150mm x 150mm. To provide a positive operation following timber shrinkage the underside of the mounting bracket must have dimples/spikes protruding to bite into the timber.

Removal and replacement of the fuse link carrier must be able to be carried out with a link stick from the ground, or a position on the pole. The forces required to, and resulting from, opening and closing the assembly must not loosen or twist the mounting bracket arrangement.

The units must be suitable for mounting at an angle of between 15 and 20 degrees to the vertical when the mounting bracket is bolted horizontally to a crossarm. The manufacturer must specify the mounting angle.
Figure 1 - Typical Type 1 EDOF arrangement and dimensions

Figure 2 - Typical Type 2 EDOF arrangement and dimensions
Each EDOF assembly must be designed and constructed so that the presence of sideways thrust during an opening or closing operation will not affect positive opening or closing of the fuse link carrier, or cause any permanent deformation of any components of the unit.

The equipment must be constructed so as to be unaffected by normal handling during transportation, installation, operation, inspection and repair.

5.4.2 Fittings

Ferrous parts must be hot dipped galvanised or must be manufactured from stainless steel. Stainless steel grade 316 parts are generally preferred. The manufacturer must state specifically those parts where galvanised ferrous parts are used instead of stainless steel.

Stainless steel bolts (grade 316) and nuts (grade 304) must be provided for all electrical connections.

The manufacturer must submit details of those items that are not in accordance with the above. Full details, including surface finish, must be submitted, including verified evidence of performance under service conditions.

5.4.3 Conductor connections

Provision must be made for the connection of copper or aluminium cables to the top and bottom contact assemblies of the EDOF. This must consist of a flat terminal palm complete with a captive 10mm stainless steel bolt. The bolt must have a free length of 30mm and be complete with a stainless steel nut and nut locking device.

The terminal palm must be made from electrical grade copper and bright tin electroplated to a minimum coating thickness of 20 microns.
5.4.4 Earth connections

A suitable earth connection facility must be fitted at or on the bottom contact assembly to accommodate the weight and dynamic forces from faults when portable earthing equipment is fitted. This facility must consist of a stainless steel “J” type arrangement made from 16mm 316 stainless steel similar to that shown below. The complete earth connection must be designed to achieve a fault rating of 16kA for one (1) sec.

![Portable earth connection device](image)

Figure 4 - Portable earth connection device

A minimum clearance of 440mm is required between the tip of the earth connection facility and the nearest conducting metal work located on the opposite side of the isolating air gap when the EDOF is open.

5.4.5 Insulators

The EDOF assemblies must have insulators with minimum nominal specific creepage distance of 31mm/kV, suitable for use in very heavy pollution environment.

Both of the following type of insulators will be considered:

- composite; and
- cycloaliphatic epoxy resin.

At present there may be a requirement for a small quantity of porcelain insulator version of both of the EDOFs. The tenderer will indicate if they have a porcelain version available and provide full details of the unit. The porcelain version will need to meet all the requirements of this specification.

They must comply with the requirements of the relevant standards.

The insulators must have adequate mechanical strength to permit the safe application of all mechanical loads applied to the insulators by virtue of opening and closing operations of the equipment, and by wind and conductor loadings.

5.4.6 Fuse base – contacts

The fuse base assembly must have a fault current breaking performance in accordance with the information in this Specification when tested with the range of fuse links specified.
The top contact must be spring-loaded wiping and silver plated to a minimum thickness of 10 microns to provide adequate service life.

The bottom contact must be bronze suitable for attaching a flipper type mechanism.

5.4.7 Fuse carriers

The manual operating mechanism (eye or hook) must be suitable for opening and closing from ground level, or from the pole by an operator using an operating stick fitted with a plain horizontal stud or hook. The fuse carrier must be suitable for removal and replacement using the same operating stick.

The top section of the fuse carrier must be rigid, securely fixed to the fuse tube, and positively located. For Type 1 EDOF, this section is to be machined and fitted with a threaded cap capable of removal and replacement with a gloved hand or, if necessary a spanner, to provide weatherproofing for the internal section of the tube. The threaded cap must be manufactured so that it can be securely and positively tightened onto the top of the fuse element so that no arcing can take place under the cap.

A flipper mechanism must be incorporated into the bottom fitting on the carrier to assist the fuse link ejection. For Type 1 EDOF, the fuse link tail must be held centrally in the tube of the fuse carrier.

The fuse must drop to the open position on every occasion that the fusible element melts or parts for any reason. Designs that are prone to hang-up failures will not be accepted.

The material used for the fuse tube must be suitable for the service conditions specified, preferably non organic.

Evidence must be provided that the fuse tube can withstand ultraviolet radiation over the expected life of the fuse carrier and assembly.

For Type 1 EDOF, it is required that the fuse link pigtail can be securely attached to the base fitting of the carrier tube.

The manufacturer must explicitly state whether or not fuse carriers offered require the fuse link to be fitted with an arc shortening rod.

5.4.8 Fuse link

For Type 1 EDOFs the fuse links must have wire type elements suitable for the following current ratings for speed class K as detailed in IEC 60282.2:

3.15A (Special to match existing fuses)
8A 16A 20A 40A 63A 80A 100A

Figure 5 - Expulsion DOF element

Figure 6 - Button type fuse link
Table 3: Button and removable head fuse link dimensions to IEC 60282.2 Figure B.1

<table>
<thead>
<tr>
<th>Rated current (A)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D (Max)</th>
<th>F (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 50</td>
<td>12,5 ± 0,2</td>
<td>19,0 ± 0,3</td>
<td>Note 1</td>
<td>5,0</td>
<td>Note 3</td>
</tr>
<tr>
<td>63 to 100</td>
<td>19,0 ± 0,3</td>
<td>Not applicable</td>
<td>Note 1</td>
<td>8,0</td>
<td>Note 3</td>
</tr>
<tr>
<td>140 to 200</td>
<td>25 ± 0,4</td>
<td>Not applicable</td>
<td>Note 1</td>
<td>9,5</td>
<td>Note 3</td>
</tr>
</tbody>
</table>

Note 1: The minimum length of the open-link fuse-links up to 15 kV included is 510mm

Note 3: The size and shape must be such that the fuse-link will freely enter a fuse-carrier having the following inside diameters:
- 7.9mm for open-link with rated current from 1A to 50A, 11.1mm for 63A to 100A.
- 17.5mm for 140 A to 200 A

For Type 2 EDOFs the fuse links must be a boric acid-power fuse design and have elements suitable for the following current ratings for speed class K as in IEC 60282.2:

3A 8A 20A 40A 65A 80A 100A

Figure 8 – Boric acid-power fuse DOF fuse element

The EDOF must be able to operate using the above fuse links and be compatible with fuses made by other manufactures.

The manufacturer must submit the following information:

- the power dissipation of the fuse link when carrying its rated current; and
- the resistance of the fuse link, measured at ambient temperature with a current not exceeding 10 per cent of its rated current.

Specifications for the above fuses are in ETS 0071.
5.4.9 Upper and lower contacts

The design of the upper and lower contact systems between the fuse carrier and assembly must be so that with the unit in the closed position, the fuse carrier is positively held to prevent arcing and inadvertent opening.

5.5 Identification and packing

The fuse bases and fuse carriers must be durably and permanently marked in accordance with section 6 of IEC 60282-2. In particular, where a carrier is offered for more than one kV/kA rating combination, the marking must clearly delineate the maximum kA rating associated with a kV rating so that no misinterpretation is possible.

The fuse carrier must be supplied with luminescent tape or other approved means of providing high visibility of the fuse carrier status (open or closed) at any time.

Each EDOF must be individually packed. The packing must be designed to prevent shock and possible damage to the EDOF during handling and transportation.

Each EDOF delivered under this specification must be tagged with the specification number, the company's stock code number and a descriptive title identifying the component. The installation instruction must be included in each box.

5.5.1 Markings on the fuse-carrier

Each fuse carrier of the EDOF must be provided with durable markings suitable for outdoor use which includes the following information:

- manufacturer's name;
- manufacturer's type designation;
- rated voltage;
- rated maximum current;
- rated breaking capacity;
- rated frequency;
- month and year of manufacture; and
- specification number.

5.5.2 Markings on the fuse-base

Each fuse base of the EDOF must be provided with durable markings suitable for outdoor use, which includes the following information:

- manufacturer's name;
- manufacturer’s type designation;
- rated voltage;
- rated maximum current; and
- month and year of manufacture.

5.5.3 Markings on the fuse-link

- manufacturer’s name;
- manufacturer’s type designation; and
- rated current and speed class.
5.6 Additional information

The following must be submitted.

- details of the installation instructions, maintenance and operating procedures needed, and a detailed list of the various components;
- a description of the EDOF operation, with instruction and maintenance manuals, including maintenance schedules;
- a list of recommended spares and tools, with the prices and availability of each item;
- details for the disposal or scrapping of the EDOF at the end of life or failure;
- details of technical back-up facilities available; and
- details of EDOF operating history, including how many in service, where and for what period, plus contact names and numbers.

5.7 Tests and inspection

5.7.1 General

All tests must be carried out by a testing authority holding appropriate accreditation:

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

However, the batch and routine tests carried out at the manufacturer’s testing facilities may be accepted provided the facilities are pre-qualified by the Manager Asset Standards & Design to perform the tests.

The pre-qualification requires an inspection of the manufacturer’s factory and the testing facility by a nominee of the Manager Asset Standards & Design.

All type and routine test reports must be accompanied by copies of the accreditation certificate/s issued to the testing laboratory. The accreditation certificate/s must be valid for the relevant test/s and for the duration of the tests.

Tests from other testing authorities, such as KEMA, may be accepted at the discretion of the Substation Assets Manager. Type tests more than five (5) years old may be acceptable at the discretion of the Substation Assets Manager.

The company reserves the right to witness the type, routine, acceptance or batch tests, for which at least four (4) weeks’ notice must be given.

All type and routine test results must meet at least the minimum requirements of clause 5.3-Technical requirements.

5.7.2 Type tests

The manufacturer must agree to the testing of the EDOF using fuse-links of other manufacture.

The following type tests must be conducted on each item supplied to the company according to the relevant standards:
Table 4: Type tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Type test</th>
<th>Acceptable value</th>
<th>Test method reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dielectric tests, including lightning impulse withstand tests and power frequency voltage withstand tests</td>
<td>No disruptive discharges for power frequency test.</td>
<td>Clause 8.4 of IEC 60282.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For impulse test the number of disruptive discharges to earth, between poles or between terminals on self-restoring insulation, does not exceed two (2) for each test condition and if no disruptive discharge on non-self-restoring insulation occurs.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Temperature rise test</td>
<td>The temperature rise of the various parts of the fuse must not exceed the limits of table 12 of IEC 60282.2 at an ambient air temperature not less than 10°C and not more than 40°C during the test.</td>
<td>Clause 8.5 of IEC 60282.2</td>
</tr>
<tr>
<td>3</td>
<td>Breaking test</td>
<td>Any failure to clear and any failure to drop out or move into the disconnected position, during any test is a failure of test duties 1 to 5 for that current rating. If such a failure occurs, in a fuse forming part of a homogeneous series, it is a failure of that homogeneous series.</td>
<td>Clauses 8.6 of IEC 60282.2</td>
</tr>
<tr>
<td>4</td>
<td>Test for time/current characteristics</td>
<td>If the curves represent minimum values of time and current, the actual points established by tests must lie within a distance corresponding to +22 -0 percent on the current scale.</td>
<td>Clauses 8.7 of IEC 60282.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the curves represent average values of time and current, the actual points established by tests must lie within a distance corresponding to ± 10 percent on the current scale</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Radio interference voltage test</td>
<td>2500μV</td>
<td>Clause 6.9.1.1 of AS 62271.1</td>
</tr>
<tr>
<td>6</td>
<td>Mechanical tests</td>
<td>The fuse base and carrier must remain in an operable condition, with no cracks in the insulator(s) or loosening hardware. The fuse links must show no damage such as rupture, loosening, slipping of connections, or elongation of components.</td>
<td>Clauses 8.8 of IEC 60282.2</td>
</tr>
<tr>
<td>7</td>
<td>Test for verification of spark production Class A</td>
<td>The number of sparks recorded must be zero (0)</td>
<td>Clause 3.1.4 and Appendix B of</td>
</tr>
</tbody>
</table>
5.7.3 Routine tests

Routine tests, as required in the relevant standards, must be carried out as a normal requirement of the contract, and may be witnessed by the company.

No additional charge must be levied for such tests or for the production or presentation of documentation related to routine tests.

Duplicate copies of routine test certificates must be submitted with the equipment. The company reserves the right to witness routine testing, for which at least two (2) weeks’ notice must be given.

The following routine tests must be conducted on each item supplied to the company according to the relevant standards:

Table 5: Routine tests

<table>
<thead>
<tr>
<th>No.</th>
<th>Routine test</th>
<th>Acceptable value</th>
<th>Test method reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dielectric test, dry-power frequency voltage withstand test</td>
<td>No disruptive discharges</td>
<td>Clause 8.4 of IEC 60282.2</td>
</tr>
<tr>
<td>2</td>
<td>Dimensional test</td>
<td>Fuse base fixed contact spacing and the fuse carrier contacts are within ±1mm of design length</td>
<td>Go/No go template based on design criteria</td>
</tr>
<tr>
<td>3</td>
<td>Design and visual checks</td>
<td>Check complete EDOF to verify its compliance</td>
<td>Clauses 7.5 of AS62271.1</td>
</tr>
</tbody>
</table>

5.7.4 Submission of test reports

Type test reports must be submitted to the Substations Assets Manager, prior to the approval of the equipment. Routine test reports must be submitted for each EDOF supplied. Reports written in any language other than English must not be accepted by the company unless the reports are translated into English by a sworn translator.

5.8 Approval process

5.8.1 Product approval and audit form:
In addition to all technical data, complete information on the item must be provided on Branch form (Asset Standards & Design) FAE 3087 – Expulsion drop-out fuse assemblies approval and audit form.
5.8.2 Product approval process

The company will approve the equipment for use on the network. The product must be evaluated under the product approval process set out in Branch Procedure (Asset Standards & Design) PAE 1004 – Product approval process.

5.9 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 this specification, including any variations;
• making all decisions concerning compliance in respect to this specification;
• nominating the company’s representative(s) for either the manufacturing facility inspection and/or witness testing; 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; and
• making recommendations concerning compliance in respect of this specification; and
• making nominations of the company’s representatives.

Substation Assets Manager has authority and responsibility for:
• reviewing all type and routine test reports and alternative proposals submitted for evaluation, and making recommendations to the Manager Asset Standards & Design;
• clarifying all the technical aspects of this specification to the stakeholders; and
• approving the relevant actions required and outlined in this specification.

Contractor Operations Manager has the authority and responsibility for confirming all equipment installed by Level 1 Accredited Service Providers complies with the requirements of this specification.

Commercial Manager has the authority and responsibility to certify that the equipment purchased through the tender process complies with the requirements of this specification.

Manufacturers/suppliers have the authority and responsibility for:
• establishing awareness of their responsibilities under this specification;
• determining the contractor/s under their control have provided suitable training for their employees;
• implementing an effective safety, environmental and quality auditing system is in place; and
• implementing this specification and keeping the company or other responsible equivalent officers informed of any factors that may prevent them from accepting responsibility for its full implementation.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Substation Assets Manager

Documentation Distribution Coordinator : Branch Process Coordinator