

Transmission Surge Arresters

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Revision History

This amendment replaces the following specifications:

ETS 0011 – 132kV/66kV/33kV/22kV/11kV Transmission Surge Arresters Am. 1

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Contact Information

The latest version of this document and other standards, are located on Endeavour Energy's standards website located at:

<http://www.endeavourenergy.com.au/aspPortal/webengine/au/com/ee/asp/Standards/Standards>.

For any enquiries relating to the content of this document please contact the Standards Coordinator on 13 10 81.

Document Control

Documentation content coordinator: Engineering Delivery Manager

Documentation process coordinator: Branch Process Coordinator

Contents

1	Documentation Scope	4
2	References	4
3	Definitions and Abbreviations	5
4	Actions	6
4.1	General requirements	6
4.2	Health, safety and environment (HSE) requirements	7
4.3	Technical requirements	7
4.4	Construction requirements	8
4.5	Testing	10
4.6	Documentation	12
4.7	Additional information	13
4.8	Packing	13
4.9	Product approval	13
5	Responsibilities	14

1 Documentation Scope

The scope of work consists of the design, manufacture, testing at manufacturer's works and delivery of 132kV, 66kV, 33kV, 22kV and 11kV transmission surge arresters.

It is not the intention to specify the manufacturing, testing and material requirements in detail. However, the arresters must be manufactured to the highest quality standards. The scope includes all items that are necessary for the operation of the equipment, where specified.

All supplied surge arresters must be manufactured and tested to the standards with the year of publication listed in section 2.0 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 **Engineering Delivery Manager** for approval prior to acceptance.

2 References

External Regulations	
NSW Work Health and Safety Act 2011	
NSW Work Health and Safety Regulation 2017	

External Standards		
Standard No.	Year	Title
ENA Doc 01	2019	ENA National Electricity Network Safety Code
AS 1111.1	2015	ISO metric hexagon bolts and screws – Product grade C – Bolts
AS 1111.2	2015	ISO metric hexagon bolts and screws – Product grade C – Screws
AS 60099.4	2022	Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems
AS/NZS 1768	2021	Lightning protection
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 3000MHz
AS/NZS 4680	2006 (R2017)	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 7000	2016	Overhead line design
IEC 60099.4	2014	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems

SA TS 60815.1	2020	Selection and dimensioning of high voltage insulators intended for use in polluted conditions
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Company Policies and Procedures

Company Policy (Network) 9.2.1 – Network Planning

Company Policy (Network) 9.2.5 – Network Asset Design

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

Division Procedure GNV 1094.1 Testing of network equipment: Surge arresters (pre commissioning) tests

Branch Procedure PAE 1004 Product approval process

Branch Forms FAE 3132 Transmission surge arrester product approval form

Company Standards

Earthing Design Instruction EDI 0004	Earthing design, construction and testing of overhead transmission mains
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Earthing Design Instruction EDI 516	Major substation earthing, design, construct and commissioning
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Substation Design Instruction SDI 520	Lightning protection and insulation coordination
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3 Definitions and Abbreviations

Term	Definition
COV	continuous operating voltage
FMECA	Failure mode, effects and criticality analysis
NATA	National Association of Testing Authorities
pd	partial discharge
RMS	root mean square
Shall	indicates a statement is mandatory
SWER	single wire earth return
TOV	temporary over voltage
UV	Ultra violet

4 Actions

4.1 General requirements

4.1.1 General

The surge arresters specified in this instruction are to be used for over voltage protection of power transformers, outdoor busbars, overhead lines, cables or any other equipment generally used in a transmission network. The arresters shall be suitable for use on the 132kV, 66kV, 33kV, 22kV and 11kV 3-phase 50Hz system.

The arresters shall be suitable for outdoor use. Outdoor arresters may be mounted on steel, concrete, wood, composites or any other structure and be bonded to earth. The arresters must be installed in accordance with SDI 520.

4.1.2 Service conditions

The service conditions are in accordance with the requirements of clause 5.4 of AS 60099.4. Additional requirements may be indicated in this document as appropriate.

The equipment shall also be designed for operation in the following conditions:

Table 1 – Service conditions

Description	Criteria
Ambient temperature	–10 deg. C to 50 deg. C
Relative humidity	100%
Altitude	0 to 1000m
Solar radiation	1.1kW/m ²
Wind speed	34 m/s
Pollution level	Very heavy in accordance with SA TS 60815.1:2020
Average annual lightning ground flash density	3 strikes per km ²

4.1.3 Environment

All ferrous parts shall be treated to provide acceptable surface finish and protection. The manufacturer shall provide full details of the surface finishing and tests conducted on all component parts

The insulation level shall be in accordance with the technical requirements stated. All insulation shall be of a type and quality that will give normal life expectancy without deterioration.

All equipment shall be designed in such a way that there is no safety hazard to operating personnel.

The manufacturer must provide details of the recommended maintenance procedures.

4.2 Health, safety and environment (HSE) requirements

4.2.1 Special environment requirements – toxicology report

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.

4.2.2 Limits of radiated radio disturbance

The radiated radio disturbance from the surge arrester must comply to Table 1 & 2 of AS 2344:2016.

4.3 Technical requirements

Table 2 – Summary of Technical requirements

Table 2 – Summary of Technical Requirements					
Description	11kV	22kV	33kV	66kV	132kV
Applicable standards	AS 60099.4:2022 and IEC 60099.4:2014				
System conditions					
Rated voltage	11kV	22kV	33kV	66kV	132kV
Highest system voltage	12kV	24kV	36kV	72.5kV	145kV
Rated frequency	50Hz				
System earthing conditions	Effective earth	Effective/ non-effective earth	Effective/ non-effective earth	Effective/ non-effective earth	Effective earth
Indoor/outdoor use	Outdoor				
Maximum prospective short circuit current	20kA	20kA	31.5kA	31.5kA	31.5kA
Duration of short circuit	1 sec				
Connection to the system	Phase to earth				
Arrester duty					
Maximum continuous operating voltage (MCOV) ph-E using 5% harmonic content and maximum system voltage, Uc	7.3kV	14.5kV	21.8kV	43.9kV	87.9kV
Minimum rated voltage (ph-E) for:					

<i>Effectively earthed neutral systems</i>	9.1kV	18.2kV	27.3kV	54.9kV	109.9kV
<i>Non effectively earthed neutral systems</i>	15kV	30kV	45kV	90.6kV	181.2kV
Nominal (8/20µs impulse) discharge current, In	10,000A				
TOV (ph-E) for effectively earthed	10.2kV	20.4kV	30.6kV	61.5kV	123.1kV
TOV (ph-E) for non-effectively earthed	15kV	30kV	45kV	90.6kV	181.2kV
Duration of short time over voltages	2 sec				
Maximum residual voltage across surge diverter – at surge diverter assuming a 10 kA 8/20 us impulse current – (kV peak)	67.9kV	103.6kV	121.4kV	232.1kV	464.3kV
Arrester class	SM				
High current pressure relief test current (0.2 secs)	50 kA				
Arrester housing					
Housing	Silicone				
Colour	Light grey				
Lightning impulse withstand (8/20 µS wave)	95kV peak	145kV peak	170kV peak	325kV peak	650kV peak
Power frequency withstand (1min)	28kV rms	50kV rms	70kV rms	140kV rms	275kV rms
Pollution level	Very heavy				
Cantilever strength	≥350Nm				

4.4 Construction requirements

4.4.1 General

The surge arresters to be supplied against this specification shall be metal oxide in a silicone rubber housing. The surge arresters shall have non-linear voltage-current characteristics and the characteristics must be submitted as part of the tender. The surge arresters must be suitable for operation under the defined operating conditions and must meet the required performance requirements.

The surge arresters shall be suitable for installation in outdoor transmission network, and may be mounted on transformer tanks, poles, support structures, overhead to underground installations, and the like.

The metal oxide block and the silicone housing shall be assembled in such a way that there is no air gap between the block and the housing walls. This is required to preclude any pressure build-up within the housing.

The arrester design and manufacturing process must confirm that the performance characteristics of the arrester are not affected by changes in the ambient conditions, such as temperature or humidity, within the criteria provide in Table 1.

The housing must be impervious to moisture and dust and shall have proven performance under specified conditions. The manufacturer shall submit the detail design, materials used and manufacturing process of the surge arresters.

The arrester shall comply with all non-shattering requirements as defined by the referenced Standards. Means shall be provided to either pressure relieve or otherwise prevent the arrester from shattering, in case the arrester malfunctions.

Failure of the arrester should be easily visible from outside without any electrical testing.

4.4.2 Surge arrester assembly

The surge arrester shall be supplied fully assembled ready for mounting. The manufacturer shall specify the maximum permissible terminal loads relevant for installation and service, such as cantilever, torque and tensile loads.

4.4.3 Mounting

The 132kV, 66k, 33kV, 22kV and 11kV surge arresters are normally mounted on steel support structures in a switchyard. These arresters shall be supplied with all accessories required for pedestal mounting. The base of the pedestal mounting shall be insulated. The manufacturer shall submit complete detail and drawings of the pedestal mounting assembly.

Some of the surge arresters are of the pole mounted type and shall be suitable for mounting vertically upright or inverted, horizontally or at any angle in between. The mounting holes must suit the pole mounting bracket as shown in drawing numbers: 77162 and 77154.

4.4.4 Terminals

The arresters shall be provided with suitable terminals for connection to the line and to earth. The terminals, both on the line side and on the earth side, shall be of stainless-steel grade 304 or 316 and shall be supplied with all required nuts, bolts and washers.

The line terminals shall be suitable for stranded conductors up to 61/3.25 AAC or 95mm² copper cable. The earth terminals shall be 14mm hole or M12 stud to connect cable lugs for 95 mm² or 120mm² cables or 50mm x 3mm copper straps. The manufacturer shall submit complete details and drawings of the line and earth terminals.

All ferrous nuts, bolts, washers and clamps used for any purpose other than for current carrying shall be hot dip galvanised.

All bolts, washers and clamps attached to current carrying parts shall be manufactured from stainless steel grade 304, and all nuts shall be from stainless steel grade 316.

All bolts and clamps, which may be required to carry an electrical current, shall be fitted with stainless steel spring washers.

4.4.5 External finish and colour

The housing of the arresters must be light grey, similar to smoke blue colour T33 of AS 2700:2011.

Other colours may be acceptable at the discretion of the Engineering Delivery Manager.

4.4.6 Name plates

Each arrester shall be provided with a nameplate incorporating details in accordance with clause 4.1 of AS 60099.4. These details shall be clearly visible and shall preferably be marked on the housing. The marking shall be permanent, weatherproof and corrosion proof.

The following minimum shall be provided:

- Continuous voltage
- Rated voltage
- Nominal discharge current
- Rated short circuit current in kiloamperes (kA)
- Pressure relief rated current
- Manufacturer's name or trademark, type and identification
- Year of manufacture

4.5 Testing

4.5.1 General

All tests shall 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 Engineering Delivery Manager to perform the tests.

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 Engineering Delivery Manager. Type tests more than five (5) years old may be acceptable at the discretion of the Engineering Delivery Manager.

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

4.5.2 Type tests

The following type tests shall be conducted on the offered surge arresters according to the relevant standards:

Table 3 – Type test

No.	Type test	Acceptable value	Test method reference
1	Insulation withstand tests	No disruptive discharge (refer to section 4.3 of this document)	Clauses 8.2.6 and 8.2.8 of AS 60099.4:2022
2	Residual voltage tests	Manufacturer to provide	Clauses 8.3.2 and 8.3.3 of AS 60099.4:2022
3	To verify long term stability under continuous operating voltage	Clause 8.4 of AS 60099.4:2022	Clause 8.4 of AS 60099.4:2022

4	Repetitive charge transfer withstand	≤ 1 sampled failed during 1st sequence or ≤ 2 samples failed during 2 sequences	Clause 8.5 of AS 60099.4:2022
5	Heat dissipation behaviour verification of test sample	Cooling curve of the section, the relative over temperature $\geq$ the complete arrester or unit.	Clause 8.6 of AS 60099.4:2022
6	Operating duty tests	- Thermal recovery has been demonstrated - Residual voltage at nominal discharge current measured before and after test is within $\pm 5\%$.	Clause 8.7 of AS 60099.4:2022
7	Power frequency voltage versus time test	- Thermal recovery has been demonstrated - Residual voltage at nominal discharge current measured before and after test is within $\pm 5\%$.	Clause 8.8 of AS 60099.4:2022
8	Short circuit test	Clause 8.10.6 of AS 60099.4:2022	Clauses 8.10 & 10.8.10 of AS 60099.4:2022
9	Bending moment test	Clauses 10.8.11.4 (a) of AS 60099.4:2022	Clause 8.11 & 10.8.11 of AS 60099.4:2022
10	Seal leak rate test	Clause 8.13.4 of AS 60099.4:2022	Clause 8.13 of AS 60099.4:2022
11	Radio interference voltage test	$< 2500\mu\text{V}$ at $1.05 \times U_c$	Clause 8.14 of AS 60099.4:2022
12	Test to verify the dielectric withstand of internal components	Clause 8.15.3 of AS 60099.4:2022	Clause 8.15 of AS 60099.4:2022
13	Test of internal grading components	Clause 8.16 of AS 60099.4:2022	Clause 8.16 of AS 60099.4:2022
14	Weather ageing test	Clauses 10.8.17.2.3 & 10.8.17.3.2 of AS 60099.4:2022	Clause 10.8.17 of AS 60099.4:2022

4.5.3 Routine tests

The following routine tests shall be conducted on each surge arrester supplied to Endeavour Energy according to the relevant Standards:

Table 4 – Routine test

No.	Routine test	Acceptable value	Test method reference
1.	Measurement of reference voltage	As specified by manufacturer	Clause 9.1 (a) of AS 60099.4:2022
2.	Residual voltage tests	$<$ value specified by the manufacturer	Clause 9.1 (b) of AS 60099.4:2022

3.	Internal partial discharge test	< 10pC	Clause 9.1 (c) of AS 60099.4:2022
4.	Seal leak rate test	Clause 8.13.4 of AS 60099.4:2022	Clause 9.1 (e) of AS 60099.4:2022
5.	Current distribution test for multi-column arrester	< value specified by the manufacturer	Clause 9.1 (f) of AS 60099.4:2022

4.5.4 Acceptance report

Acceptance tests in accordance with Clause 9.2 of AS 60099.4:2022 shall be conducted. The quantity to be tested shall be made on the nearest lower whole number to the cube root of the number of arresters to be supplied.

Table 5 – Acceptance test

No.	Acceptance test	Acceptable value	Test method reference
1.	Measurement of power frequency voltage at the reference current	As specified by manufacturer	Clause 9.2.1 (a) of AS 60099.4:2022
2.	Lightning impulse residual voltage	< value specified by the manufacturer	Clause 9.2.1 (b) of AS 60099.4:2022
3.	Internal partial discharge test	< 10pC	Clause 9.2.1 (c) of AS 60099.4:2022
4.	Special thermal stability test	Thermal stability occurs in all 3 samples	Clause 9.2.2 of AS 60099.4:2022

4.5.5 Submission of test reports

Type test reports shall be submitted to the Engineering Delivery Manager prior to the approval of the equipment. Acceptance test must be supplied for each purchase order while routine test reports shall be submitted for each surge arrester supplied.

Reports written in any language other than English will not be accepted by Endeavour Energy unless the reports are translated into English by a sworn translator.

4.6 Documentation

As part of the integrated system support requirements, the manufacturer/supplier shall submit the following documentation prior to the delivery of the surge arrester to Endeavour Energy as follows:

- One (1) electronic copy of the complete installation and maintenance manual shall be provided for each surge arrester type according to its voltage rating, covered in a single contract. Each manual shall relate specifically to the surge arrester supplied and must not contain any material that is not applicable. Each manual shall include:
 - A comprehensive index.
 - Detailed technical information of the surge arrester and its internal components.
 - Sectional views/photos of the internal components of the surge arrester.
 - Instructions for receiving, storing and handling of the surge arresters.
 - Installation instructions.
 - Copy of all detailed drawings.
 - A complete list of parts.

- Instructions for the maintenance of the surge arrester and its components.
- Recommended maintenance schedules (inclusive of FMECA and reliability centered maintenance)
- Type test reports.
- Routine test reports.

4.7 Additional information

The following shall be submitted:

- A list of recommended spares and tools, with the prices and availability of each item.
- Details of technical back-up facilities available.
- Details of how surge arresters shall be disposed or re cycled when it has reached its end of life or failure.
- Details of surge arrester operating history, including: how many in service, where and for what period with contact names and numbers.

4.8 Packing

The supplier shall suitably pack each surge arrester in a box or wooden crate complete with all accessories such as bolts and nuts.

All measures shall be taken to determine that damage will be avoided during packing, transporting and handling.

The following shall be written in BLACK lettering on each box or wooden crate:

- Voltage rating of the surge arrester.
- Manufacturer's part number.
- Endeavour Energy and stock code.
- Contract number.
- Supplier's name.
- Mass.

4.9 Product approval

4.9.1 Product approval and audit form

Complete information of the surge arrester and its components shall be provided on FAE 3132.

4.9.2 Product approval process

Engineering Delivery Manager will approve the equipment/components for use on the network. The surge arrester must be evaluated under the product approval process set out in PAE 1004.

5 Responsibilities

Chief Asset & Operating Officer has the authority and responsibility for:

- Approving technical specifications including any variations.

Head of Asset Planning & Performance has the authority and responsibility for:

- Reviewing technical specifications and making recommendations to **Chief Asset & Operating Officer** for major changes in respect to this instruction.
- Making recommendations concerning compliance in respect to this specification.

Engineering Delivery Manager has the authority and responsibility for:

- Keeping the contents of this instruction up to date.
- Reviewing all test reports submitted and making recommendations to the **Head of Asset Planning & Performance**.

