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NPS/001/008 – Technical Specification for Gapless Metal Oxide Surge Arresters

1. Purpose

The purpose of this document is to detail the technical requirements for gapless metal oxide surge arrestors used on the 11kV, 20kV, 33kV, 66kV and 132kV overhead line distribution networks of Northern Powergrid.

This document supersedes the following documents, all copies of which should be destroyed.

Document Reference	Document Title	Version	Published Date
NPS/001/008	Technical Specification for Gapless Metal Oxide Surge Arresters	6.0	June 2020

2. Scope

This document applies to non-linear gapless metal oxide surge arresters without spark gaps which are designed to limit over voltages on the distribution network of Northern Powergrid in accordance with IMP/007/011 - Code of Practice for the Application of Lightning Protection. This specification is applicable to 11kV, 20kV, 33kV, 66kV and 132kV overhead lines and 33, 66 and 132kV ground mounted substations. The following appendices form part of this technical specification.

- Appendix 1 - Key Technical Ratings
- Appendix 3 - End of Life Disposal
- Appendix 4 - Addendum to Supplier Requirements
- Appendix 5 - Pre-Commission Testing, Routine Inspection and Maintenance Requirements
- Appendix 6 - Schedule of Surge Arrester Requirements
- Appendix 7 - Technical Information Check List

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3. Technical Requirements

3.1. General

Gapless metal oxide surge arresters shall be designed and tested in accordance with BS EN 60099 Part 4: 2014. The ranges of products include 11kV, 20kV and 33kV pole mounted stand-off arresters and pedestal type arresters for 66kV and 132kV arrangements. In all instances surge arresters will be used as a means of mechanical support for a cable termination, overhead line jumper or bus bar arrangement.

3.2. Service Conditions

The arrester shall be suitable for operation under normal service conditions as detailed in BS EN 60099 – 4 Clause 5.4.1 with the addition of the following: -

Condition	Value	Information from -
Rainfall	3mm/minute	BS EN 60721-2-1:2014 Table 1
Ice Loading	10mm radial	Company requirement
Orientation	Vertical or horizontal	Company requirement

3.3. System Parameters

Surge arrestors shall be compatible with the system parameters detailed in the table below.

Rated Voltage	11kV	20kV	33kV	66kV	132kV
Maximum System Voltage (kV rms)	12	24	36	72.5	145
Rated Frequency (Hz)	50	50	50	50	50
Rated Current (A)	630	630	800	800	2000
Maximum Fault Currents					
phase-phase (kA rms)	13.1	10.1	20	20	25
phase-earth (kA rms)	4	4.5	4.5	3.5	20
Fault Duration					
phase-phase (seconds)	3.0	3.0	3.0	3.0	3.0
phase-earth (seconds)	10	10	10	10	3
Maximum Earth Fault Factor	1.73	1.73	1.73	1.73	1.4
Lightning Impulse Withstand Level – (1,25/50 μs) kV peak	95	125	170	325	650
Power Frequency Voltage – Wet Withstand (kV)	45	70	90	140	275
Creepage Distance (mm) (25kV/mm)	300	600	900	1815	3625
Flashover Distance (mm) Basic electrical Clearance Phase – Earth (BS EN 61936-1 : 2021) table 1	160	220	320	630	1300
Short Circuit Current Rating (MVA)	250	350	1145	2286	5700

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3.4. Arrestor Performance

The arrestors shall meet the performance requirements in accordance with BS EN 60099 Part 4 as summarised in the table below:-

Surge Arrestor Performance	11kV	20kV	33kV	66kV	132kV
Line Discharge Class (BS EN 60099 – 4)	DH	DH	DH	DH	DH
Nominal Discharge Current (kA)	10	10	10	10	10
High Current Impulse (kA)	65	65	100	100	100
Highest System Voltage Rating (kV) U_m	15.0	24.0	36.0	72.0	145.0
Continuous Voltage (kV) (MCOV)	12.0	19.2	28.8	57.6	116
Over voltage Capability (kV for 1 second)	17.1	27.4	41.4	82	140
Rated Short Circuit Current – Outdoor Application (kA)	16	16	25	25	25

3.5. Identification and Classification

3.5.1. Identification

The minimum identification requirements are detailed in BS EN 60099 - 4, Clause 4.1. This information shall be permanently attached to the arrester.

3.5.2. Classification

Arrester shall be classified in accordance with BS EN 60099 - 4, Clause 4.2.

3.6. Construction

3.6.1. Composite Materials

The insulation of surge arrester shall be of a moulded design and be void free (with routine testing in place to prevent this). The insulating material will be Silicon Rubber with a preference towards a mould in place process.

Composite materials used in the manufacture of insulators shall be traceable from the raw material supplier through the manufacturing process as required under quality assurance procedures.

The insulating material will be described by the manufacturer in defined terms. The use of a generic term such as silicone rubber is not acceptable.

3.6.2. Housing and Sheds

The housing is the external insulating part of an insulator which provides the necessary creepage and protects the internal components from the weather.

Due to the variations in the make-up of silicon rubber materials and the potential effects this may have on the long term performance the material must have the following properties:-

- UV resistance
- Tracking resistance
- Hydrophobicity

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The table below provides a good practice guide relating to the composite material content and how the above properties may be provided.

Material Composition	Minimum % per weight
Silicone Polymer (Polydimethylsiloxane) (PDMS)	30%
Filler (ATH Aluminium tri hydrate and fumed silica)	64%
Additional parts (pigments, crosslinkers)	1%

Where manufacturers differ from this characteristic composition, they shall provide supporting evidence about the long term experience of their product formulation.

The following table provides a list of characteristic properties that result from the above formulation. Manufacturers shall provide details of their characteristic properties for consideration.

Property	Minimum Value
Density	1.5g/ccm
Passing Voltage level of IEC 60587	4.5kV
Tensile Strength (Din 53504-S1)	6 N/mm ²
Break Elongation (Din 53504-S1)	300%
UV resistance - @ 300nm the energy of UV wave length equates to a molecular energy breakdown level of 398kJ/mole *	445 kJ/mole

* Assumed wavelength of UV light (sun) 290 – 350nm

Surge arresters shall be manufactured using the HTV (high temperature vulcanising) and shall ensure that the interface between the housing and the core is chemically bonded. Flash or mould lines shall not exceed 1mm in height.

3.7. Mechanical Loads

Surge arresters may be used as a means of mechanical support and must therefore be suitable for mounting at any angle between the horizontal and vertical. The arresters must therefore satisfy the mechanical loading tests given in BS EN 60099 – 4 and the table below.

	11 kV	20kV	33 kV	66kV	132kV
Cantilever (Nm)	350	350	350	350	350
Torsion (Nm)	50	50	50	50	50
Tension (kN)	2	2	2	2	2

3.8. Short Circuit Failure

Polymeric housed arresters should fail with the housing intact or housing broken down non-explosively in accordance with Clause 6.13 “Short Circuit Performance “ and Clause 8.10 of BS EN 60099 – 4.

3.9. Testing

Gapless metal oxide surge arrestors shall be tested in accordance with BS EN 60099 – 4 with type tests as required in section 10. Routine tests shall be carried out in accordance with BS EN 60099 – 4, Sections 9.

In addition to standard type tests 100% of arresters shall be tested for internal partial discharge with the arrester energised at 1,05 times the operating voltage (pass result will be ≤10pC). Also 100% of blocks used in arrester

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assembly shall be residual voltage tested as required in Section 6.3 of BS EN 60099 - 4. Block sample testing shall also include high current impulse testing at appropriate peak 65kA or 100kA.

Appendix 2 of this specification contains self-certification conformance declarations that shall be completed by the supplier for each product offered.

3.10. End of life Disposal

Manufacturers shall provide enough information within Appendix 3 so that all the arrester components may be scrapped and/or recycled in accordance with international and national regulations.

3.11. Mechanical End Fitting Requirements

Voltage Type and NPg Commodity Code	Description
11kV 224071	This Item shall be supplied with M12 stainless steel studs at each end (<u>length 45mm dead end – 60mm live end</u>) complete with 2 flat washers and 2 spring washers* per stud. Additionally this item shall be supplied with a flat mounting plate. The arrangement shall be generally in accordance with our drawing 1091480162 sht2
20kV 244213	This Item shall be supplied with M12 stainless steel studs at each end (min length 45mm) complete with 2 flat washers and 2 spring washers* per stud. Additionally this item shall be supplied with a flat mounting plate. The arrangement shall be generally in accordance with our drawing 1091480162 sht3
33kV 224113	This Item shall be supplied with M12 stainless steel studs at each end (min length 50mm) complete with 2 flat washers and 2 spring washers* per stud. The top stud shall include a line conductor clamp suitable for conductor sizes of 4-35mm diameter. The bottom stud shall be mounted on a pedestal base designed for a 127mm PCD c/w 4xM12 set screws and both flat and spring washers. The base shall be mounted on a set of 4 polyfibre base insulators with 105mm creepage c/w M12 x 20mm deep insert in both ends and M12x 35mm hex head set screws. Additionally the pedestal base shall include a ground connecting plate c/w 2xM10 set screws suitable for the connection of 70mm CSA earthing conductor. This arrangement can be used in a stand-off insulator mode, suspended from the crossarm on a c/c/37 construction or with the supplied pedestal base adjacent to a self -supporting cable termination The arrangement shall be generally in accordance with our drawing 1091480165 sht3
66kV 224154	This Item shall be supplied with M16 stainless steel studs at each end (min length 50mm) complete with 2 flat washers and 2 spring washers* per stud. The top stud shall include a line conductor clamp suitable for conductor sizes of 4-35mm diameter. The bottom stud shall be mounted on a pedestal base designed for a 127mm PCD c/w 4xM12 set screws and both flat and spring washers. The base shall be mounted on a set of 4 polyfibre base insulators with 105mm creepage and c/w M12 x 20mm deep insert in both ends and M12x 35mm hex head set screws. Additionally the pedestal base shall include a ground connecting plate c/w 2xM10 set screws suitable for the connection of 70mm CSA earthing conductor. This arrangement shall be generally in accordance with our drawing 1091480166 sht1
66kV	Surge Arrester, 66kV Moulded Polyfibre Base

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224156	
132kV 224155	<p>This Item shall be supplied with M16 stainless steel studs at each end (min length 50mm) complete with 2 flat washers and 2 spring washers* per stud.</p> <p>The top stud shall include a line conductor clamp suitable for conductor sizes of 4-35mm diameter. The bottom stud shall be mounted on a pedestal base designed for a 280mm PCD c/w 4xM12 set screws and both flat and spring washers. The base shall be mounted on a set of 4 polyfibre base insulators c/w M12 x 20mm deep insert in both ends and M12x 35mm hex head set screws. Additionally the pedestal base shall include a ground connecting plate c/w 2xM10 set screws suitable for the connection of 70mm CSA earthing conductor.</p> <p>This arrangement shall be generally in accordance with our drawing 1091480166 sht3</p>
132kV 224157 Substation Class Surge Arrestor	<p>132kV (Silicone Rubber) polymeric housed, gapless, zinc oxide, Surge Diverter c/w L5 line terminal clamp and corona ring (Cond range 4mm-35mm), E2 ground connector c/w 2xM10 Set Screws and spring washers*, M5 pedestal base designed for a 280mm PCD fixing c/w 4xM16 flat and spring washers, and a M4 set of 4 polyfibre base Insulators</p>

*Note – Spring washers used on end fittings studs shall have the ability to ensure that the nuts do not vibrate loose and when fitted, not cause any damage to the threaded stud. The spring washers must retain their properties after being applied several times.

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4. References

The products described within this specification shall comply with all current versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply.

4.1. External Documentation

Reference	Title
BS EN 60060 – 1: 2010	High-voltage test techniques. General definitions and test requirements
BS EN 60099 Part 4: 2014	Surge arresters. Metal-oxide surge arresters without gaps for a.c. systems
BS EN 60587; 2007	Electrical insulating materials used under severe ambient conditions. Test methods for evaluating resistance to tracking and erosion
BS EN 60721-2-1: 2014	Classification of environmental conditions. Environmental conditions appearing in nature. Temperature and Humidity
BS EN 61936-1: 2021	Power installations exceeding 1 kV AC and 1,5 kV DC.
BS EN 62217 : 2013	Polymeric HV insulators for indoor and outdoor use. General definitions, test methods and acceptance criteria
DIN 53504 : 2017	Testing of rubber - Determination of tensile strength at break, tensile stress at yield, elongation at break and stress values in a tensile test
ENA ER G109	Lightning protection for networks up to and including 132kV
ENA TS 41-36 Issue 3: 2012	Distribution switchgear for service up to 36kV (cable and overhead conductor connected)
ENA TS 43-93 Issue 5: 2018	Line Insulators

4.2. Internal Documentation

Reference	Title
IMP/007/011	Code of Practice for the Application of Lightning Protection

4.3. Amendments from Previous Version

Reference	Description
4.1 External Documentation	Latest versions referenced and requirements reviewed

5. Definitions

Term	Definition
n/a	

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6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	10/10/2022

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period;

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
No	Period: 5 Years	Reason: Update will be dictated by contact renewal date or any significant changes in the specification or documents referenced.
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Steven Salkeld	Policy and Standards Engineer	24/08/2022

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
G Hammel	Senior Policy and Standards Engineer	22/08/2022
J Helm	Policy and Standards Manager	27/09/2022

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	System Engineering Manager	30/09/2022

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Appendix 1 – Key Technical Ratings

The template below shall be completed with the ratings supported with appropriate type test evidence, drawings and data sheets.

Description	11kV Stand-off Type with M12 Mounting Studs.	20kV Stand-off Type with M12 Mounting Studs.	33kV supplied c/w Polyfibre Base Insulator	66kV with Pedestal Base	66kV - Moulded Polyfibre Base	132kV (Pole Mounted)	132kV Substation class
NPg Code	224071	244213	224113	224154	224156	224155	224157
Technical Requirement							
Line Discharge Class (BS EN 60099 – 4)							
Nominal Discharge Current (kA)							
High Current Impulse (kA)							
Rated Voltage (kV)							
Continuous Voltage (kV)							
Impulse Voltage (kV) – 1,25/50 us							
Over voltage Capability (kV for 1 second)							
Rated Short Circuit Current – Outdoor Application (kA)							
Power Frequency Voltage – Wet Withstand (kV)							
Flashover Distance (mm)							
Creepage Distance (mm)							
Overall Length (mm)							
Unit Weight (kg)							
Packaging Type							

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Cantilever (Nm)							
Torsion (Nm)							
Tension (kN)							

Material properties for Arrester Housing	
Material Composition	(Min % per weight of material)
Silicone Polymer (Polydimethylsiloxane) (PDMS)	
Filler (ATH Aluminium tri hydrate and fumed silica)	
Additional parts (pigments, crosslinkers)	
Property	Minimum Test Value for material being offered
Density	
Passing Voltage level of BS EN 60587	
Tensile Strength (Din 53504-S1)	
Break Elongation (Din 53504-S1)	
UV resistance - @ 300nm the energy of UV wave length equates to a molecular energy breakdown level of 398kJ/mole *	
Type of Silicon vulcanisation (LTV or HTV)	

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Appendix 2 - SELF CERTIFICATION CONFORMANCE DECLARATION

Gapless Metal Oxide Surge Arrestors are covered by BS EN 60099 Part 4: 2014 and shall comply with the latest issues of the relevant national and international Standards.

BS EN 60099 Part 4 is intended to amplify and/or clarify the requirements of those Standards.

This check sheet identifies the clauses in BS EN 60099 -4 and the clauses of the aforementioned Standards relevant to Gapless Metal Oxide Surge Arrestors for use on current the Northern Powergrid distribution network.

The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

Conformance declaration codes

N/A = Clause is not applicable/ appropriate to the product

Cs1 = The product conforms fully with the requirements of this clause

Cs2 = The product conforms partially with the requirements of this clause

Cs3 = The product does not conform to the requirements of this clause

Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Manufacturer:

Product Reference:

Name:

Signature:

Date:

Instructions for completion

- When Cs1 code is entered the supplier shall provide evidence of conformance referencing the appropriate document
- When any other code is entered the reason and supporting evidence for non-Conformance shall be entered
- Prefix each remark with the relevant 'BS EN' or 'ENATS' as appropriate

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Gapless Metal Oxide Surge Arrestors

BS EN 60099 Part 4; 2014.			
Clause/Sub-clause	Requirement	Conformance Code	Evidence Reference and Comments
Clause 4.1	Arrestor Identification		
Clause 4.2	Arrestor Classification		
Clause 5.0	Standard Ratings and Service Conditions		
Clause 6.1	Insulation withstand of the arrestor housing		
Clause 6.2	Reference Voltage		
Clause 6.3	Residual voltages		
Clause 6.4	Internal partial Discharges		
Clause 6.5	Seal Leak rate		
Clause 6.6	Current distribution in a multi-column arrestor		
Clause 6.7	Thermal stability		
Clause 6.8	Long duration current impulse withstand		
Clause 6.9	Operating Duty		
Clause 9.0	Routine tests		
Clause 10.0	Test requirements on polymer-housed surge arresters		
Clause 10.8.2	Insulation withstand tests on the arrestor housing		
Clause 10.8.3	Residual voltage tests		
Clause 10.8.4	Long duration current impulse withstand test		

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Clause 10.8.5	Operating duty test		
Clause 10.7	Short Circuit Test		
Clause 10.8.8	Internal partial discharge test		
Clause 10.8.9	Bending moment		
Clause 10.8.11	Seal Leak rate		
Clause 10.8.12	Radio Interference (RIV)		
Clause 10.8.14	Weather ageing test Test series B – 5000h test		

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Clause/Sub-clause	Requirement	Conformance Code	Evidence Reference and Comments
Section 3.3	Compliance with System Parameters		
Section 3.4	Arrestor Performance Requirements		
Section 3.6.1	Pollution Levels		
Section 3.6.2	Insulation Type		
Section 3.6.3	Insulation Material Composition		
Section 3.7	Mechanical Loads Requirements		
Section 3.9	Additional Testing Requirements		

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Appendix 4 - Addendum to Supplier Requirements

Packaging/delivery information

Details of how this product will be packaged and delivered shall be provided.

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Appendix 5 - Pre-Commission Testing, Routine Inspection and Maintenance Requirements

Suppliers shall provide details of the recommended pre-commission testing and inspection required. They shall also provide information regarding periodic inspection and maintenance requirements to be undertaken during the lifetime of their product.

Detailed inspection and maintenance instructions shall be also be provided.

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Appendix 6 – Schedule of Surge Arrester Requirements

Cat Number	Description
224071	Surge Arrester, 11kV Stand-off Type with M12 Mounting Studs.
244213	Surge Arrester, 20kV Stand-off Type with M12 Mounting Studs.
224113	Surge Arrester, 33kV supplied c/w Polyfibre Base Insulator, earth connection plate and conductor clamp
224154	Surge Arrester, 66kV with Pedestal Base
224156	Surge Arrester, 66kV - Moulded Polyfibre Base
224155	Surge Arrester, 132kV (Pole Mounted)
224157	Surge Arrester, 132kV Substation class

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Appendix 7 - Technical Information Check List

The following information shall be provided by the supplier for technical review by Northern Powergrid. Additional information shall be provided if requested.

Requirement	Provided (Y/N)
Full product descriptions and part number/reference	
Appendix 1 – Completed technical schedules	
Appendix 2 – Completed self-certification conformance declaration	
Appendix 3 – End of Life Disposal recommendations	
Appendix 5 – Inspection and testing recommendations	
Complete set of drawings and data sheets for each variant	
Type test evidence	
Routine test and/or product quality plan (sample)	
Packaging/delivery information	