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Metal-Oxide Surge Arresters for Use on 132, 275 and 400 kV Systems

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METAL-OXIDE SURGE ARRESTERS FOR USE ON 132, 275 AND 400 kV SYSTEMS

FOREWORD

This Specification defines the requirements for surge arresters connected to the National Grid Company plc (NGC) transmission system.

1 SCOPE

The requirements for both porcelain and metal-enclosed surge arresters connected directly between phase-and-earth of the power system are specified.

2 REFERENCES

This Specification makes reference to and should be read in conjunction with:

IEC 60	(BS 923) - High-voltage test techniques: Parts 1, 2, 3 and 4.
IEC 99-4:	1991-11 Surge Arresters. Part 4: Metal-oxide surge arresters without gaps for a.c. systems.
IEC 99-1:	1991 - Surge Arresters. Part 1: Non-linear resistor type gapped arresters for a.c. systems.
IEC 99-3:	1990 - Artificial pollution testing of surge arresters.
IEC 507	Artificial pollution tests on high-voltage insulators to be used on a.c. systems.
BS 5049	Method of measurement of radio noise from power supply apparatus for operation at 1 kV and above.
NGTS 1	Overview, National Grid System.
NGTS 2.1	Substations.
NGTS 2.2	Switchgear for use on 132, 275 and 400 kV systems.

3 FUNCTIONAL REQUIREMENTS

3.1 All surge arresters shall comply with NGTS 1, NGTS 2.1, NGTS 2.2 and IEC 99-4.

3.2 The arresters shall operate without failure, operation of the pressure-relief device or change exceeding ± 5% to the protective levels declared by the manufacturer (based on routine test results for the specific arrester), throughout the design life.

3.3 Unless otherwise specified the surge arresters shall be suitable for connection between each phase and earth, they shall be self-supporting and suitable for upright mounting.

3.4 All surge arresters shall be provided with means for pressure-relief to ensure that an arrester failure cannot rupture or cause explosive shattering of the housing for all conditions within its declared rating.

3.5 A surge counter shall be supplied together with a permanent leakage current indicator or provision for external leakage current measurement, all of which shall be readable or accessible with the surge arrester in service.

3.6 The surge counter shall be connected such that the total current through the arrester passes through the counter.

3.7 For connections between the arrester and surge counter or permanent current indicator which may be subject to high voltage during the passage of arrester conduction current, one of the following additional requirements shall be met:

(i) The supplier shall demonstrate that the voltage will not exceed 650 V rms.

(ii) The connections and associated terminals shall be shrouded and insulated to an impulse level of 15 kV.

(iii) Safety clearances in accordance with Table 2 of NGTS 2.1 shall be provided from any position or platform to which access is normally permitted.

3.8 The earth connection shall remain electrically continuous after being subject to the maximum arrester current and duration specified for the location.

Additional Requirements for Porcelain-enclosed Arresters

3.9 The arrester performance shall be maintained with the arrester mounted on a structure of minimum height specified in NGTS 2.1, irrespective of the proximity of other apparatus, (which may or may not be at earth potential), and walls or other structures at minimum distances to those specified in NGTS 2.1.

3.10 The high voltage connection from the busbar to the arrester shall be specified by the arrester manufacturer. Suitable terminals and fittings shall be provided at the line end of the arrester. Details of the proposed conductor and fittings shall be provided by the supplier at the enquiry stage such that:

(i) The connections remain intact and serviceable after being subject to the relevant short time current and duration, for the specific location.

(ii) The radio noise emitted by the complete arrester associated monitoring equipment and all connections shall not exceed the values in Table 1, Item 11 when measured in accordance with BS 5049.

Additional Requirements for Non-porcelain Housed Air Insulated Arresters

3.11 Non-porcelain housed arresters, not covered by international standards, require special considerations and specific approval must be sought from NGC.

Additional Requirements for Metal-enclosed Arresters

3.12 The metal-enclosure insulation structure and accessories shall comply with NGTS 2.1. The contractor shall identify those locations where it is necessary to mount the metal-enclosed surge arresters on vibration dampers.

4 PERFORMANCE REQUIREMENTS

4.1 All arresters and their associated equipments shall comply with the performance requirements in IEC 99-4. Additional requirements are given in Table 1.

Table 1 - Required Surge Arrester Performance Characteristics

	PERFORMANCE CHARACTERISTICS	SPECIFIED REQUIREMENTS (ii)		
		132 kV	275 kV	400 kV
1	Continuous Operating Voltage	≥ 100 kV rms	≥ 200 kV rms	≥ 285 kV rms
2	Surge Arrester Rated Voltage (i)	≥ 132 kV rms	≥ 260 kV rms	≥ 360 kV rms
3	Nominal Discharge Current (ii)	10 kA peak	10 kA peak	10/20 kA peak
4	Line Discharge Class (ii)	≥ 3	≥ 3	≥ 3
5	Impulse Current Withstand	100 kA peak	100 kA peak	100 kA peak
6	Lightning Impulse Protective Margin (iii)	≥ 40 % @ 10 kA peak	≥ 40 % @ 10 kA peak	≥ 40 % @ 20 kA peak
7	Switching Impulse Protective Margin (iv)	n/a	≥ 25 % @ 2 kA peak	≥ 25 % @ 2 kA peak
8	Steep Current Impulse (20 kA peak) Residual Voltage	≤ 1.15 X Max. LIRV	≤ 1.15 X Max. LIRV	≤ 1.15 X Max. LIRV
9	Pressure Relief Class to IEC 99-1: 1991 (v)	20, 40, 50, 63 or 80 kA dependant upon the Earth Fault current at the specific location.		
10	Cantilever Strength (vi)	≥ 2 kN	≥ 2 kN	≥ 2 kN
11	Radio Interference (vii)	≤ 125 µV	≤ 200 µV	≤ 250 µV

Notes applicable to Table 1

(i) 10 s TOV withstand voltage as defined in IEC 99-4.

(ii) Dependant upon the application, may require 10 kA or 20 kA Nominal Discharge Current and a line discharge class greater than that specified in the Table.

(iii) The figure of Lightning Impulse Protective Margin (LIPM) is pending for an international agreement.

$$LIPM = \frac{LIWL - LIRV}{LIRV} \times 100\%$$

LIWL = Lightning Impulse Withstand Level (kVpk)
LIRV = Lightning Impulse Residual Voltage (kVpk)

(iv) The figure of Switching Impulse Protective Margin (SIPM) is pending for an international agreement.

$$SIPM = \frac{SIWL - SIRV}{SIRV} \times 100\%$$

SIWL = Switching Impulse Withstand Level (kVpk)
SIRV = Switching Impulse Residual Voltage (kVpk)

(v) This test only applies to Porcelain house arresters fitted with pressure relief device, other design eg polymeric house arresters will require test to demonstrate its short circuit behaviour.

(vi) Cantilever load to be withstood assuming point load at high voltage terminal including insulating base. Applications where surge arresters are used to support significant lengths of busbars may require greater cantilever strength.

(vii) As measured in accordance with BS 5049:1973 at 92, 191, 267 kV rms for 132, 275, 400 kV systems respectively.

5 TEST REQUIREMENTS

5.1 General

Test evidence supported by descriptions of the test method showing the mechanical characteristics of the arrester, seal integrity, shock/vibration withstand etc submitted by the manufacturer will be considered by NGC in assessing the suitability of the equipment for 'type approved' status.

All types of surge arrester shall be subject to type and routine tests as specified in IEC 99-4. Details of the test method to be used for radio interference and partial discharge tests are to be declared to NGC 14 days prior to carrying out the type/routine test.

For certain applications or unorthodox designs of surge arrester additional tests also may be called for to demonstrate specific performance characteristics required.

The manufacturer will be required to propose test methods or submit evidence to demonstrate that the operation counter and associated monitoring equipment (eg current indicator) can withstand the relevant short time fault current and duration for the specific location. (See clause 3.10)

5.2 Porcelain-enclosed Surge Arresters

5.2.1 Until such time as an internationally agreed pollution test is established, all surge arresters supplied for use on the NGC system will be subject to pollution type tests specified in Appendix A.

Subject to the agreement of the manufacturer, the temperature to which the metal-oxide blocks are pre-heated for the combined operating duty test will be based on the highest temperature reached in each unit during the pollution test.

Surge arresters for outdoor applications, without the NGC preferred shed profile (see NGTS 2.2 Item 4.4) will be subject to the 'heavy wetting' type test detailed in Appendix B.

5.2.2 Routine tests to demonstrate seal integrity and surge arrester operation counter/current indicator function are required.

5.2.3 The supplier shall specify any commissioning tests necessary to ensure the satisfactory function of the equipment throughout the design life. A short duration high voltage d.c. 'fingerprint' test as described in Appendix C shall be carried out on each arrester unit over the range 1 μA - 1 mA. Where tests are performed by NGC the supplier will be required to witness these tests and confirm that equipment guarantees have not been invalidated.

5.3 Metal-enclosed Surge Arresters

5.3.1 Until such time as an internationally agreed standard for metal-enclosed surge arresters is available, type tests for the mechanical characteristics (including pressure withstand and pressure-relief) will be in accordance with NGTS 2.1 and NGTS 2.2 Specifications. Type tests for the electrical characteristics will be as for open-type arresters except for the following items:

(i) Insulation withstand on arrester housing.

(ii) Pressure-relief test on enclosures. (see NGTS 2.1 Specification).

(iii) Pollution tests (not required).

The suppliers proposals are required for type tests for Items (i) and (ii) above and also to show that:

(i) Satisfactory voltage grading is attained across all zinc oxide blocks.

(ii) The thermal model of the arrester section used for the operating duty tests is representative of the most highly stressed parts of the arrester.

(iii) All other tests including accelerated ageing tests are carried out with the blocks under physical conditions identical to those in service (eg same atmosphere).

5.3.2 The supplier shall nominate any commissioning tests necessary to ensure satisfactory function of the equipment throughout the design life. These shall include IEC 99-4 clause 8.2.1(c). The supplier will be required to witness these tests and confirm that equipment guarantees not been invalidated.

5.4 In Service Condition Monitoring

The supplier shall advise any technique to monitor the condition of the surge arrester throughout its design life.

6 TECHNICAL DATA OF EQUIPMENT SUBMITTED FOR APPROVAL

The requirements for surge arresters approval are as detailed in NGTS 2.2. Where required, Appendix D shall be completed by the supplier in support of approval.

APPENDIX A

POLLUTION TESTS

A1 GENERAL

The tests will be carried out as stated below pending publication of internationally agreed standard methods. The following test procedures may be subject to variation to accommodate particular application requirements, test plant availability and developments in test techniques. The tests as proposed incorporate the current views of CIGRE Task Force 33.04.06.

Two pollution tests shall be performed, a Natural Pollution Test (A3 below) and an Artificial Pollution Test (A4 below). A complete arrester which has been routine tested shall be used for each test.

Temperature indicating tapes covering the range 40-200°C shall be affixed to at least five varistor blocks, approximately equally distributed along the varistor column in each unit of the test arrester. The location and fixing of the tapes and any other temperature monitoring equipment shall not affect the stress distribution or thermal characteristics of the arrester.

To permit separate recording of internal and external currents the bottom shed of the bottom unit will be coated with a suitable compound such as grease and an electrode affixed to the housing within 100 mm of the bottom flange.

A2 TEST OBJECTIVES AND PASS/FAIL CRITERIA

The objectives of the tests are:

A2.1 To demonstrate that the arrester remains intact and serviceable after exposure to pollution as required in A3 and A4 below. This will be proven by routine tests and visual inspection of all components when the arrester is dismantled.

A2.2 To determine the start temperature for the test sample used for the combined operating duty test. The pass criteria will be that thermal stability is achieved at completion of the combined operating duty test.

Note: The thermal model used for the combined operating duty test will comprise at least two metal-oxide blocks in series in each column. Where the complete surge arrester consists of more than one unit, the model will comprise at least one block per unit in each column. The start temperature of each block shall be equal to the maximum temperatures found in each unit during the natural and artificial pollution tests.

A3 NATURAL POLLUTION

The arrester for test shall be erected at a site to be agreed between NGC and the supplier and shall be energised with power frequency voltage not less than

$1/\sqrt{3}$ x Nominal System Voltage (see NGTS 1, Table 1)

for at least one year total duration. The objective is to expose the test sample to representative weather conditions and associated seasonal variations throughout the year.

The power frequency voltage source shall meet the requirements given in BS 923 : Part 2 : 1980 (IEC 60-2) and shall not be interrupted at times of onerous climatic conditions.

The porcelain housing shall not be cleaned at any time during the test period.

Internal and external current and the charge current per hour, will be monitored during the test.

After the test the arrester shall be subjected to repeat routine tests and a detailed visual internal and external examination in the presence of NGC and the manufacturer. The maximum temperatures indicated in each unit shall be recorded (see A2 - Note)

A4 ARTIFICIAL POLLUTION

A4.1 Preparation

Before the artificial pollution tests all surfaces of the arrester porcelain enclosure shall be thoroughly cleansed of contamination using water, lint-free cloths and a scouring agent agreed by NGC and the supplier. The requirement is that wetting of surface should occur as experienced in service. After cleansing, the arrester shall be allowed to drain.

A4.2 Test Conditions

The applied pollution shall be saline fog and its method of production shall be in accordance with Clause 8 of IEC 507.

The applied power frequency voltage shall be

$1/\sqrt{3}$ x Maximum System Voltage (see NGTS 1 Table 1)

and the magnitude shall be monitored continuously during the test sequence and shall not depart from the specified values by more than +2%. The bottom unit internal and external current and charge per hour shall be recorded continuously during the test in a permanent form. Highest current peaks will be recorded to confirm the withstand condition of the external insulation.

Pollution severities of 2.5, 5 and 10 kg/m^3 of NaCl shall be applied. The arrays of special spray jets, flow rate and air supply pressure to be in accordance with IEC Publication 99-3 (1990).

A4.3 Test Sequence

After preparation in accordance with A4.1 above the arrester is energised in accordance with A4.2 above and the salt fog then applied and maintained without interruption for six hours. The fog is then removed and the arrester de-energised and cleaned with tap water and allowed to drain. If external flashover occurs the sample should be re-energised immediately. If this results in a further flashover the test is terminated and the arrester deemed unsatisfactory.

Two tests shall be carried out at each pollution severity.

A4.4 Post-Test Assessment

At the conclusion of the test the arrester shall be subjected to repeat routine tests and a detailed visual internal and external examination in the presence of the manufacturer and NGC. The highest temperature indicated in each unit shall be recorded (see A2 - Note).

APPENDIX B

HEAVY WETTING TEST

B1 GENERAL

A salt fog deposit is applied to the insulator surface using a standard salt fog artificial pollution test (IEC 507). The insulator is allowed to drain. Heavy wetting is then applied from sprays and any flashovers noted.

B2 TEST CONDITIONS

Salt fog salinity (constant for each application)	40 - 160 kgm^{-3}
Fog duration	15 minutes
Duration of draining period	15 minutes
Heavy wetting flow rate	2 mm/minute
Water conductivity	2000 ±250 $\mu s\ cm^{-1}$
Heavy wetting duration	1 minute

B3 TEST METHOD

Tests are made at increasing salinities and until 3 withstands out of 4 tests occur with the arrester energised at $1/\sqrt{3}$ x Maximum System Voltage for equipment (see NGTS 1 Table 1). The voltage is applied prior to the application of fog and not removed until completion of the heavy wetting. Three jets are used arranged vertically approximately 2 m from the insulators and displaced at 90° around the circumference. The spray falls at an angle of approximately 45° to the vertical onto the sheds.

B4 PASS/FAIL CRITERIA

A minimum of 3 withstands out of 4 tests shall be obtained at 80 kg/m^2

Note: The arrester housing used for tests in Appendix A may be used for the heavy wetting test.

APPENDIX C

D.C. "FINGERPRINT" INJECTION TEST

General

No international standard is currently available to verify the condition of a metal oxide gapless surge arrester before energisation, and therefore a d.c. injection method was developed by NGC TSD to examine the surge arrester during the commissioning.

The a.c. current through a metal oxide surge arrester consists of two parts, the capacitive component and the conductive component. The conductive current through the arrester will give a clear indication to its condition. Using d.c. voltage, the conduction current through the arrester can be established.

Before energisation, a current versus voltage characteristic of the right up to the "knee point" of the non-linear resistance is being recorded for each arrester section of a complete high voltage metal oxide surge arrester. Ideally this test needs to be repeated periodically to make sure the characteristic of the surge arrester does not shift.

Apparatus

1 HV d.c. power supply capable to deliver minimum 1 mA at the rated voltage of the longest surge arrester section.

2 Calibrated high resolution d.c. μA and mA ammeter for monitoring the conduction current through a surge arrester section.

3 Calibrated d.c. voltage meter for monitoring the voltage across a surge arrester section.

Procedure

Before starting the tests, the surge arrester must be disconnected from the busbar and also its bottom flange isolated from the surge counter.

The output of the high voltage d.c. power supply is connected to the top of the surge arrester. For multi-section surge arresters, temporary bridge connections are applied to those sections are not under test.

A temporary connection to earth is applied to the bottom flange of the section under test.

An earthed circumferential guard ring is applied to the porcelain housing about half inch above the bottom flange of the section under test in order or intercept the external leakage current.

D.C. voltage is applied to the test unit until a steady conduction current of 5 μA, 10 μA, 100 μA, 500 μA and 1 mA are achieved. The corresponding voltages are recorded. Attention must be given to the operations at 500 μA and 1 mA as the arrester is operating very close to the "knee point".

The test duration for each operating current must be kept to as short as possible especially when 1 mA d.c. is passing through the arrester.

The metrological data during the test are to be recorded.

APPENDIX D

SURGE ARRESTER CHARACTERISTICS

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
Section 1	**SUPPLIER INFORMATION**	
1.1	Suppliers' Name	
1.2	Suppliers' Address	
1.3	Suppliers' Full Type Designation of Surge Arrester	
1.4	Guaranteed Design Life	
Section 2	**SURGE ARRESTER ELECTRICAL PERFORMANCE CHARACTERISTICS**	
2.1	Rated Voltage (kV rms)	
2.2	Continuous Operating Voltage (kV rms)	
2.3	Nominal Discharge Current (kA)	
2.4	(a) Line Discharge Class	
	(b) Preheat Temp. for Operating Duty Test (°C)	60
2.5	Impulse withstand current (kA)	
2.6	Pressure Relief Capability (kA rms) to IEC Recommendation 99-1, 1970	
	(a) For 0.2 s Fault Duration (b) For 1.0 s Fault Duration	
2.7	Energy Input Capacity (kJ/kV[2.2]) for Complete Arrester	
2.8	Arrester Temperature Rise (°C) due to 2.7	
	(a) Minimum (b) Maximum	
2.9	Maximum Recommended Arrester Temperature (°C) before 2.7	
2.10	Maximum Steep Current Impulse Residual Voltage (kV)	
	(a) 10 kA (b) 20 kA	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
2.11	Maximum Lighting Impulse Residual Voltage (kV) at (a) Routine Arrester Test Level (b) 1 kA (c) 5 kA (d) 10 kA (e) 20 kA (f) 40 kA (g) 65 kA (h) 100 kA	
2.12	Maximum Switching Current Impulse Residual Voltage (kV) at (a) 1 kA (b) 2 kA (c) 3 kA	
2.13 (see Note 1)	Maximum Operating Current (Capacitive, mA rms) at 20°C (a) at nominal system voltage (76, 159 or 231 kV rms) (b) at rated system voltage (84, 173 or 242 kV rms) (c) at continuous operating voltage [2.2] (d) at rated voltage [2.1]	
2.14 (see Note 1)	Maximum Operating Current (Resistive mA Peak) at Nominal System Voltage (a) at 20°C (b) at 40°C	
2.15 (See Note 1)	Maximum Operating Current (Resistive mA Peak) at Continuous Operating Voltage [2.2] (a) at 10°C (b) at 20°C (c) at 30°C	
2.16	Reference Current (mA peak)	
2.17	Reference Voltage (kV rms) (a) Minimum (b) Maximum	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
2.18	Minimum Temporary Over Voltage Withstand Capability (Duration, s) with 40°C Ambient and Zero Preload and Followed by Rated System Voltage (1 pu) (a) at 1.4 pu (b) at 1.5 pu (c) at 1.6 pu (d) at rated voltage [2.1]	
2.19	Minimum Temporary Overvoltage Withstand Capability (Duration, s) with 40°C Ambient and Rated Energy Input Capacity [2.7] Pre-load Followed by Rated System Voltage (a) at 1.4 pu (b) at 1.5 pu (c) at 1.6 pu (d) at rated voltage [2.1]	
2.20 (see Note 2)	Maximum Radio Interference Voltage (μV) at 1 MHz Across 300 at Rated System Voltage	
2.21	Maximum Voltage (kV d.c.) Acceptable on Test with Direct Current [2.23] (a) at -20°C (b) at 0°C (c) at 20°C (d) at 40°C	
2.22	Minimum Voltage (kV d.c.) Acceptable on Test with Direct Current [2.23] (a) at -20°C (b) at 0°C (c) at 20°C (d) at 40°C	
2.23	Direct Current Level (mA) for HVDC Commissioning Test for which Acceptable Voltage Values Quoted [2.21, 2.22] or Reference to V1 Characteristic Showing Maximum and Minimum Values	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
2.24	Voltage (kV rms) Across Most Highly Stressed Resistor at 20°C (a) at nominal system voltage (76, 159 or 231 kV rms) (b) at rated system voltage (84, 173 or 242 kV rms) (c) at continuous operating voltage [2.2] (d) at rated voltage [2.1]	
Section 3	**ARRESTER ENCLOSURE**	
3.1	Porcelain Enclosure (where applicable)	
3.1.1	Number of Units	
3.1.2	Total Creepage Length (m)	
3.1.3	90° Protected Creepage Length (m)	
3.1.4	Internal Diameter (Nominal, mm)	
3.1.5 (see Note 4)	Reference to Shed Profile Drawing	
3.1.6	Enclosure Length per Unit (a) minimum (b) maximum	
3.2	Applicable to Porcelain and Metal Enclosures	
3.2.1 (see Note 3)	Minimum Impulse (1.2/50 μs) Breakdown Voltage (kV)	
3.2.2	Minimum Wet or Dry Power Frequency Breakdown Voltage (kV)	
3.2.3	Minimum Bursting Pressure (kPa)	
3.2.4 (see Note 4)	Reference to sealing, pressure relief arrangement	
3.2.5	Maximum pressure for operation of pressure relief (kPa)	
3.2.6	Filling gas or gas mixture (a) air (%) (b) nitrogen (%) (c) oxygen (%) (d) sulphur hexafluoride (%) (e) others - specify	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
3.2.7	Gas pressure at 10°C (a) minimum (kPa) (b) maximum (kPa)	
3.2.8	Gas pressure at 40°C (a) minimum (kPa) (b) maximum (kPa)	
3.2.9	Maximum condensation temperature (°C) of gas at maximum filling pressure	
Section 4	**INTERNAL CONSTRUCTION**	
4.1	Number of parallel resistor columns per unit	
4.2	Number of resistors per column per unit (a) minimum (b) maximum	
4.3	Number of resistors per complete arrester (a) minimum (b) maximum	
4.4	Materials used (if any) to locate resistors and/or spacers radially within the housing	
4.5	Method of applying contact pressure between resistors	
4.6	Number of grading capacitors (if any) per resistors (a) minimum (b) maximum	
4.7	Capacitance value per capacitor (pF) (a) minimum (b) maximum	
4.8 (see Note 4)	Reference to drawing showing internal construction	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
Section 5	**METAL OXIDE RESISTORS**	
5.1	Type designation of resistors	
5.2	Outside diameter (mm)	
5.3	Internal diameter (mm) where applicable	
5.4	Height (mm) per resistor	
5.5	Mass (kg) per resistor (a) minimum (b) maximum	
5.6	Heat capacity (kJ/°C) per arrester (a) minimum (b) maximum	
5.7	Designation of resistor material	
5.8	Material of contact surfaces	
5.9	Material of outside coating (s)	
5.10	Rated voltage, (kV rms) per resistor (a) minimum (b) maximum	
5.11	Reference voltage (kV rms) per resistor (a) minimum (b) maximum	
5.12	Reference current for [5.13] (mA peak)	
5.13	Residual voltage (kV) per resistor at nominal discharge current [2.3] (a) minimum (b) maximum	
5.14 (see Note 4)	Reference to resistor routine tests	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
Section 6	**COMPLETE ARRESTER ASSEMBLY**	
6.1 (see Note 4)	Reference to drawing of complete arrester assembly including external grading ring, line and earth terminals and insulating base	
6.2	Overall height (m)	
6.3	(a) Outside diameter of external grading ring (m) (b) Reference to drawing showing dimension and arrangement of grading ring	
6.4	Minimum clearance distance from top of arrester/bottom of grading ring to metal of arrester at earthed potential	
6.5	Arrester mass (a) total (kg) (b) per unit minimum (kg) (c) per unit maximum (kg)	
6.6	Cantilever strength (kN) of completely assembled arrester in vertical position (had applied at HV terminal)	
6.7 (see Note 4)	(a) with zero wind speed (b) with 46 m/s wind and 13 mm thick coating of ice	
6.8 (see Note 4)	Reference to Erection Instructions Reference to Operation and Maintenance Procedures	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
Section 7	**ARRESTER ACCESSORIES**	
7.1	Type designation of surge counter	
7.2 (see Note 4)	Reference to surge counter characteristics	
7.3 (see Note 4)	Outline drawing of surge counter	
7.4	Type designation of operating current indicator	
7.5 (see Note 4)	Reference to current indicator characteristics	
7.6 (see Note 4)	Outline drawing of indicator	
7.7	Type designation of insulating base	
7.8 (see Note 4)	Reference of insulating base drawing	
Section 8 (see Note 4)	**TYPE TEST REPORT REFERENCES**	
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8.2	Residual voltage	
8.3	Long duration current impulse withstand	
8.4	Operating Duty	
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8.5.2	Low current pressure relief test	
8.6	Natural pollution test	
8.7	Artificial pollution test	
8.8.1	Radio interference/partial discharge	
8.8.2	Test Method	
8.9	Seal leakage	

ITEM NO	ITEM DESCRIPTION	SUPPLIERS' DECLARATION
8.10	Current distribution test for multi-column arrests	
8.11	Power frequency versus time characteristic	
8.12	Mechanical characteristics	
8.13	Cantilever load	
8.14	Surge Counter	
8.15	Operating Current Indicator	
8.16	Accelerated Ageing	
8.17	Arrester housing insulations withstand tests	
Section 9	**CERTIFICATION**	
9.1	Signature of suppliers representative	
9.2	Name as above in block capitals	
9.3	Date of signing	

Note 1: Current values should be those obtained with the enclosure clean and dry (where relevant). The temperature given is that of the arrester metal oxide resistors in each case.

Note 2: With arrester housing clean and dry (where relevant)

Note 3: The breakdown voltage should apply to external or internal breakdown (including all components except the resistors) whichever is the lower

Note 4: All drawings/documents referenced should be included with any tender

RECORD OF REVISION

NGTS 3.2.3

This issue (Issue 2) has been revised and amended as follows:

REV	DATE	DETAILS OF REVISION	AUTHORISATION
2	May 1994	1 Revised Table 1 and notes 2 Revised Clause 5.2.3 3 Add Clause 5.4 4 Add Appendix C	I.M. Walsh.

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