GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

SPECIFICATION
FOR
METAL OXIDE GAPLESS TYPE LIGHTENING ARRESTER FOR USE ON 220kV, 132kV, 110kV and 66kV SIDE OF RAILWAY TRACTION SUBSTATIONS

Specification No. TI/SPC/PSI/MOGTLA/1200

This specification supersedes the specification number ETI/PSI/137(08/1989) with A&C slip no. 01 to 07

	PREPARED BY	CHECKED BY	APPROVED BY
SIGNATURE			
DATE			
DESIGNATION			

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1.0 Scope

1.1. It is to be noted that "The Make in India Policy of Government of India shall be applicable."

1.2. This specification supersedes the specification number ETI/PSI/137(08/1989) with A&C slip no. 01 to 07.

1.3. This Specification covers the design, manufacture, testing and supply of Metal Oxide Gapless type Lightening Arresters intended for outdoor installation for protection of 220kV/25kV or 132kV/25kV or 110kV/25kV or 66kV/25kV or ~~22kV/25kV~~ Single Phase, 50Hz, Traction Power Transformer and other equipments of 245/132/110/66/~~22~~kV installed in traction sub stations.

2.0 Governing Specification

2.1 The Lightening Arresters shall, unless otherwise specified herein, conform to the latest revision of RDSO Specification, Indian Standard Specifications/IEC Recommendations, as indicated below and the Indian Electricity Rules, wherever applicable.

Sl. No.	Standards	Title of the Standard
1.	IS:1367(Pt-XIII): 1983 (Reaffirmed in 2006)	Technical Supply conditions for threaded Steel Fasteners- Hot Dip Galvanised coating on threaded Fasteners
2.	IS:1570 (Part-V)-1985 (Reaffirmed in 20~~04~~ 18)	Schedule for Wrought Steels Stainless and Heat Resisting Steels (Part-V)
3.	IS:2071(Part-I)-1993 (Reaffirmed in 20~~04~~ 16)	High Voltage Test Techniques - General definitions and test requirement
4.	IS:2071 (Part-II)-1974 (Reaffirmed in 2006)	Methods of High Voltage Testing - Test Procedures
5.	IS:2099-1986 (Reaffirmed in 2003)	Bushings for Alternating Voltages above 1000 Volts
6.	IS:2629-1985 (Reaffirmed in 2006)	Recommended Practice for Hot Dip Galvanizing of Iron & Steel
7.	IS:2633-1986 (Reaffirmed in 2006)	Methods of Testing uniformity of zinc coating
8.	IS:3070 (Part-1)- 1985	Non-linear Resistor Type Surge Arresters
9.	IS:3070 (Part-III)-1993 (Reaffirmed in 2004)	Metal oxide Lightening Arrestors without Gap Surge Arresters
10.	IS :5358-1969	Hot Dip Galvanised coating on Fasteners
11.	IS:5561-~~1970~~ 2018 ~~(Reaffirmed in 2002)~~	Electric Power Connectors
12.	IS:5621-1980 (Reaffirmed in 2004)	Hollow Insulators for use in Electrical Equipment
13.	IS:6209-1982 (Reaffirmed in 2006)	Method for Partial Discharge Measurement
14.	IS:8704-~~1995~~ 2018/	Methods for Artificial Pollution Test on High Voltage Insulators for use on AC system
15.	IS:15086(Part-3)-2003	Artificial Pollution Testing of Surge Arresters
16.	IEC: 60099-4-2014/ IS:15086-4 - 2017	Metal Oxide Surge Arresters, without Gaps for AC system
17.	IEC: 60099-5:2018/ IS:15086-5 - 2001 (Reaffirmed in 2016)	Surge Arrestor- Selection, Application and Recommendation
18.	RDSO Specification No. ETI/OHE/13 (04/1984) A&C slip no. 01 to 03 or latest	Specification for Hot Dip Zinc Galvanization of Steel Masts (Rolled & Fabricated), Tubes and Fittings used on 25 kV AC OHE

2.2 Any deviation from this Specification, proposed to improve the performance, utility and efficiency of the Equipment, proposed by the firm, shall be given due consideration, provided full particulars with justification thereof are furnished.

3.0 Traction Power Supply System

3.1 General Scheme

i.) Single Phase, AC, 50 Hz Power Supply for Railway Traction at 25 kV is obtained from 220/132/110/66/~~22~~ kV 3-Phase Grid Supply, through step down Power Transformers, the Primary winding of which is connected between any two phases of 220/132/110/66 kV three phase effectively earthed Transmission networks of the Supply authorities. In order to reduce the imbalance on Three Phase, the Transmission lines are tapped in a cyclic order, for feeding successive Traction Sub-stations. The spacing between adjacent Traction Sub-Stations varies between 30 to 80 kms, depending upon the density of the traffic and gradients of the Section etc.

ii.) One Terminal of the 25 kV Secondary winding of the Traction Transformer is connected to the Overhead Equipment (abbreviated as OHE) and the other is solidly earthed and also connected to Traction Rails. The load current flows through the OHE to the locomotives and returns through Rail and earth to the Traction Sub-stations. In the middle of adjacent Traction Sub-stations, a dead zone known as 'Neutral Section' is provided to isolate the two Phases. The power to the OHE on one side of the Traction Sub-Station is fed by a Feeder Circuit Breaker. OHE of each track is controlled by an Interrupter. In case of fault on the OHE, the Feeder Circuit Breaker clears the fault.

iii.) A Schematic of a typical arrangement, showing the General Feeding arrangement of a Traction system, as well as the schematic General Arrangement at a Traction Sub-station is given in Sketch No. ETI/PSI/702-I (enclosed at Annexure-C).

iv.) The incoming 220/132/110/66~~/22~~ kV supply voltage may vary between +10% to 12.5% as per Rule No. 54 of IE Rules-2003. The supply frequency may vary by ±3%

3.2 Protection system

3.2.1 Relays are provided for the protection of Traction Transformers as indicated below. The Schematic diagram of the Protection of the Traction transformer & OHE is given in Appendix-III.

a) IDMT Over Current Protection on 220/132/110/66~~/22~~ kV side,
b) Restricted Earth Fault Protection on 220/132/110/66~~/22~~kV side,
c) IDMT Over Current on 25 kV side,
d) Restricted Earth Fault on the 25 kV side and
e) Differential Protection.

3.2.2 Relays are provided for the protection of OHE as indicated below.

a) Distance Protection,
b) Instantaneous Over Current Protection and
c) Wrong Phase Coupling Protection.

Note: At some Traction Sub-stations (part or complete), static/ microprocessor based Relays are provided.

3.3 Insulation level

Basic insulation level of the Sub Station Equipment on the 220/132/110/66kV side is as under:

SN	Parameter	220kV	132kV	110kV	66kV	~~22kV~~
a)	One minute power frequency withstand voltage in kV (rms)	395	275	230	140	~~50~~
b)	1.2/50 micro seconds impulse withstand voltage in kVp	950	650	550	325	~~125~~

3.4 25 kV OHE and Traction Transformers

3.4.1 The OHE generally consists of a stranded cadmium copper catenary of 65 sq. mm. and a grooved copper contact wire of 107 sq. mm. providing a total of 150 sq.mm. copper equivalent. The loop impedance of the OHE is as under:

The values of loop impedance of OHE without return conductor and booster transformers (BT) –

- Single track OHE 0.41 $\angle 70^0$ ohms/km
- Double track OHE 0.24 $\angle 70^0$ ohms/km
- Triple track OHE 0.18 $\angle 70^0$ ohms/km

The values of loop impedance of OHE with return conductor and booster transformers (BT) –

- Single track OHE 0.70 $\angle 70^0$ ohms/km
- Double track OHE 0.43 $\angle 70^0$ ohms/km
- Triple track OHE 0.27 $\angle 70^0$ ohms/km

3.4.2 Traction Transformer

Normally 21.6 (ONAN)/30.24 (ONAF) MVA or 30 (ONAN)/42 (ONAF) MVA, 220 or 132 or 110 or 66/27 kV, Single-Phase with maximum of (12+/-0.5)% for 21.6MVA & (12.5+/-0.5) % 30MVA impedance rating of Traction Transformer is provided at the Traction Sub-station. The Traction Transformers are designed to carry short time overloads to cater for the requirements of varying traction load.

Rating of the Traction transformer

Rated Capacity	Rated Secondary current of the Transformer	
	30 MVA	21.6 MVA
Continuous	1111 Amps	800 Amps
15 Minute	150% i.e 1666.5 Amps	150% i.e 1200 Amps
5 Minute	200% i.e. 2222 Amps	200% i.e. 1600 Amps
Ability to withstand Short Circuit	Thermal : 5 second Dynamic : 0.25 second	Thermal : 5 second Dynamic : 0.25 second

Note: The rating and design of the Traction Transformer may change hence manufacturer/supplier must confirm the ratings and configuration from the Purchaser.

4.0 Nature of faults on the OHE system

4.1 OHE may be subject to frequent earth faults, or snapping of OHE and its touching the Rail or earth, or loose wires carried by birds coming in contact with OHE below over line structures, miscreant activities etc.

Faults are cleared by Feeder Circuit Breakers, which operate alone or with any of the following Relays depending on the proximity of the fault:-

a) Distance Protection Relay (Pollygonal characteristics),
b) Instantaneous Over Current Relay,
c) Inadvertent coupling of two phases between adjacent Traction Sub-stations at the Neutral Section or at intermediate Switching Stations, in case of extended feed may cause short circuits, which are cleared by one of Feeder Breaker at either end of Traction Sub-stations through a "Mho Relay" known as “Wrong Phase Coupling Relay (WPC)”.

4.2 Short Circuit level

For different Grid Supply Voltages, Short Circuit level on Primary side of Traction Transformer may vary between 7 to 8 kA depending upon the proximity of the Traction Sub-station to the Generating Station. The level of short circuit on the 25 kV side for a fault in the vicinity of a Traction Sub-station could be around 6-10 kA.

The short- circuit apparent power for various system voltages is as under, however the actual values shall be furnished by Purchaser in consultation with Supply Authority:

Highest System Voltage (in kV)	Short Circuit Apparent Power (in MVA)
~~22~~	~~1000~~
66kV	3500
110kV	6000
132kV	10000
220kV	20000

5.0 Environmental conditions

5.1 All Equipments, suitable for Outdoor/Indoor, shall be suitable for use in tropical climate and in areas subjected to heavy rainfall, pollution due to industrial and coastal climates and severe lightening surges in India.

i. Maximum Temperature of Air in shade : 55^0 C
ii. Minimum Temperature of Air in shade : (-)10^0 C
iii. Max. Temperature attainable by an object exposed to Sun : 70^0 C
iv. Maximum Relative Humidity : 100%
v. Annual Rainfall ranging from : 1750 mm to 6250 mm
vi. Maximum Number of Thunder storm days per annum : 85 days
vii. Maximum number of Dust Storm days per annum : 35 days
viii. Number of Rainy days per Annum : 120 days
ix. Basic Wind Pressure : 200 kgf/m^2
x. Altitude above Mean Sea Level : 1000 meters

5.2 The lightening arrester would also be subjected to chemical pollution from the effluent gases of chemical plants and exhausts of the steam/diesel locomotives and to saline atmosphere in coastal areas.

5.3 Vibrations

The Equipment is expected to be installed on foundation in the ground or on Steel Structures located by the side of Railway tracks and be subjected to vibrations due to the passage of trains. The amplitude of these vibrations lies in the range of 30 to 150 microns, with instantaneous peaks going up to 350 microns. These vibrations occur with rapidly varying time periods in the range of 15 to 70 milliseconds.

6.0 Technical Specification

6.1 Rating and other Particulars

The technical particulars and performance characteristics of the Lightening Arrester shall be as under:

SN	Description	Ratings/ Particulars				
i.	System	Three Phase AC system solidly earthed				
ii.	Nominal system voltage (Phase to phase)	~~22kV~~	66kV	110 kV	132 kV	220 kV
iii.	Possible variation	~~22 +10%, -12.5%~~	66 +10%, -12.5%	110 +10%, -12.5%	132 +10%, -12.5%	220 +10%, -12.5%
iv.	Rated Frequency	~~50Hz~~	50Hz	50Hz	50Hz	50Hz
v.	Type of Lightening Arrester	Non Linear, metal oxide resistor type, without gaps				
vi.	Line Discharge Class		Class 3	Class 3	Class 3	Class 3
vii.	Continuous Operating Voltage Capability (Phase to Earth)		50kVrms	90kVrms	95kVrms	168kVrms

viii.	Maximum Discharge Voltage at Nominal Discharge Current		160kVpeak	250kVpeak	350kVpeak	550kVpeak
ix.	Nominal Discharge Current (8/20 µs wave)		10kA	10kA	10kA	10kA
x.	Power Frequency Voltage Withstand for Arrester Insulation		117kV rms	174kV rms	228kV rms	380kV rms
xi.	Pressure Relief Class		Class A	Class A	Class A	Class A

6.2 Construction

6.2.1 **(i) LA with Porcelain Housing**

a. The Lightening Arrester shall comprise of number of non-linear Resistor Blocks, housed inside the Porcelain Housing. Suitable provisions to arrest the relative movement of Blocks shall be provided inside Porcelain Housing.

b. Lightening Arrester shall be of hermetically sealed construction to prevent moisture ingress inside the Porcelain Housing. A sealing gasket of Silicon Rubber with a Dumbel shaped shall be used.

c. The Arrestor shall have means for relieving internal pressure to prevent explosive shattering of the housing.

d. The Pressure Relief Device shall be Class-A as per ~~IS: 3070 (Part-III)-1993 (Reaffirmed in 2004)~~ IS: 15086-4: 2017.

(ii) LA with Polymer Housing

a. The Lightening Arrester shall comprise of number of non-linear metal-oxide Resistor Blocks with highly non-linear voltage-current characteristics, connected in series.

b. The surge arrester with a housing made of polymeric material without air voids neither between the housing and the metal-oxide resistors nor the housing itself. Arresters must have directly moulded housings. Arresters manufactured by slip-on, pre moulded housing will not be accepted in view of the weak interface between the housing and the assembled disc. The polymer material which is used for the arrester housing must be tracking and erosion resistant, stabilized against UV radiation.

c. **Cage Design of Polymer Surge Arresters to be used**: To accommodate the stack of Metal Oxide elements, the Metal Oxide elements should be used as mechanically supporting part. This should be achieved by clamping them in between the end fittings using a cage of FRP rods. The silicone rubber insulation is then moulded directly onto the MO elements without any internal gas volume left.

d. Bonding Between Housing and Metal-Oxide Resistors

i. The adhesion between the polymeric housing and the metal-oxide resistors or any other metallic or non-metallic parts inside the housing must be strong enough, homogeneous, robust and resistant to thermal cycles and environmental stresses.

ii. The Lightening Arrestor shall be suitable for outdoor installation, where the maximum temperature attainable by an object exposed to sun is 70°C. If required, the manufacturer shall use Polymer of light color instead of brown color to avoid over-heating of the internal components of the Arrester for its satisfactory service.

6.2.2 The arresters shall be provided, if necessary with metal guard ring, circular in shape to modify electrostatically the voltage gradient.

6.2.3 The arresters shall have base support suitably designed for mounting on a base plate over a steel supporting structure as per details given in the following table:

	220kV	132kV	110kV	66kV
Number of bolts (equally spaced)	6 (60 degree apart)	3 (120 degree apart)	3 (120 degree apart)	3 (120 degree apart)
Size of Bolt	M-12	M-16	M-16	M-16
Pitch circle Diameter	254mm	222mm	222mm	222mm

6.2.4 The arrestor shall be provided with a Terminal Connector conforming to IS: 5561. The Connector shall be of robust design and as per approved Drawing, suitable for securing in ACSR-Zebra conductor (28.62mm diameter) on the live side. Suitable provision on the Earth side of the Arrester shall be made for connecting two numbers ~~45X6~~ 75mmx8mm Mild Steel flats. An Earthing Pad with two holes of 13.5 mm diameter is preferable. All the Hardware required for mounting the Lightning Arrester, Insulating base and Surge Monitor etc. shall be supplied by the manufacturer.

6.2.5 All Ferrous Parts, used in manufacturing of Lightening Arrester, its assembly and the Insulating Base shall be hot-dip galvanised. All fasteners of diameter up to 12mm shall be of stainless steel confirming to grade 04 Cr17Ni 12 Mo2 of IS: 1570 (Part-V) and those above 12 mm shall preferably be of Stainless Steel or of Mild Steel Hot Dip Galvanised to RDSO's Specification no. ~~ETI/OHE/18(4/84).~~ TI/SPC/OHE/FASTENERS/0120 Rev.01 or latest.

~~6.2.6 Bushings~~

~~The Hollow Porcelain bushing shall be procured from RDSO approved sources only. The following are the approved sources:~~

~~i.) M/s Aditya Birla Insulator ltd. Hallo & Rishra~~

~~ii.) M/s Insulator Electrical Company Mandideep Bhopal~~

~~iii.) M/s Modern Insulators Ltd. Abu road~~

~~iv.) M/s WSI Chennai~~

6.3 Insulating Base

One number Insulating Base, of porcelain shall be supplied by the manufacturer along with each Arrestor. The Insulating Base shall have same mounting dimension as that of Lightening Arrestor mentioned in clause no. 6.2.3.

6.4 Surge Monitor

6.4.1 To monitor the healthiness of the Lightening Arrester, each Arrester shall be provided with a Surge Monitor. Surge Monitor shall be designed to record directly the number of surges handled by the Lightening Arrester on a cyclometric counter, and also indicate the leakage current passing through the Lightening Arrester, on an ammeter, continuously. No Push Button shall be provided in the ammeter circuit, for taking the reading of the leakage current.

6.4.2 Surge monitors shall be interchangeable and suitable for outdoor service. Suitable Terminal Connectors and leads etc. shall be supplied along with the surge monitor, so that these can be installed at a convenient height for ease of visibility. Suitable provision on the earth side of the surge monitor shall be made for connecting two numbers ~~45X6mm~~ 75mm x 8mm Mild Steel flats as indicated in Para 6.2.4 above. The design of 'Surge Monitor' shall be such that in the eventuality of its failure, the Lightening Arrester base should automatically be connected to the Earth system.

6.5 ~~Tenderer~~ Vendor may quote separately for:

i.) Surge monitor

ii.) Insulating base

6.6 Name plate

Each Lightening Arrester shall be provided with Name-Plate legibly and indelibly marked with the following information:

i. Arrester Type - (Porcelain/Polymer)
ii. Continuous Operating Voltage,
iii. Rated Voltage,
iv. Rated Frequency,
v. Nominal Discharge Current,
vi. Long Duration Discharge Current,
vii. Pressure Relief Class,
viii. Manufacturer's Name or Trade-mark, Type and Identification,
ix. Month & Year of Manufacture
x. Purchase Order Number and
xi. Manufacturer's Serial Number

6.7 The Lightening Arrestor shall be suitable for outdoor installation, where the maximum temperature attainable by an object exposed to sun is 70°C. If required, the manufacturer shall use Porcelain of light color instead of brown color to avoid over-heating of the internal components of the Arrester for its satisfactory service.

7.0 Type tests

Following Type tests shall be carried out in accordance with ~~draft IEC TC37 WG4 January 87~~ IS:15086 (Part 4):2017 to prove the general quality of design and its conformity with the Specifications:

SN	Tests	IS:1508 (Part-4):2017 applicable clause
1.	~~Power Frequency~~ Reference Voltage of an Arrester ~~Test~~	3.56 & 8.7
2.	Insulation Withstand Test i) Lightening Impulse Voltage Test ii) Power Frequency Voltage Test	8.2 8.2.6 8.2.8
3.	Residual Voltage Tests i) Steep Current Impulse Residual Voltage Test ii) Lightening Impulse Residual Voltage Test iii) Switching Impulse Residual Voltage Test	8.3 8.3.2 8.3.3 8.3.4
4.	~~Long Duration Current Impulse Withstand Test~~ Test to verify long term stability under continuous operating voltage	8.4
5.	Test to verify the repetitive charge transfer rating, Qrs.	8.5
6.	Heat Dissipation Behavior of Test Samples	8.6
7.	Operating Duty Tests	8.7
8.	Power-frequency voltage-versus-time test	8.8
9.	Short-circuit test	8.10
10.	Test of the bending moment	8.11
11.	Environmental tests	8.12
12.	Seal leak rate test	8.13
13.	Radio interference voltage (RIV) test	8.14
14.	Test to verify the dielectric withstand of internal components	8.15
15.	Test of internal grading components	8.16
16.	~~i) Accelerated Ageing Test~~ ~~ii) Switching Surge Operating Duty Test~~ ~~iii) Evaluation of Thermal Stability in Operating Duty Test~~	~~6.6~~ ~~6.6.2~~ ~~6.6.3~~ ~~6.6.5~~ ~~6.6.6~~ ~~6.6.7~~
17.	~~Pressure Relief Test~~	~~6.7~~

18.	~~Artificial Pollution Test~~ ~~This test is to be carried out as per ANSI/ IEEE C 62.11.1987~~ Polluted housing test	~~Annexure J~~ Annexure C
19.	~~Leakage Test on complete Arrester Assembly to see the efficacy of the sealing system~~	~~Every Surge Arrester shall call for into a water bath of 1.5 meter depth for half an hour period on Routine basis.~~ ~~This Test is expected to be detecting sealing defect.~~
20.	~~Other miscellaneous Tests~~ ~~i) Galvanizing test on Metal Parts~~ ~~ii) Porosity Test on Porcelain Components~~ ~~iii) Temperature Cycle Test on Porcelain Housing~~ ~~iv) Visual Examination of Porcelain Housing~~	

8.2 For polymers housing arresters, the modifications in the type tests mentioned in Para 8.1 above shall be done as detailed in the clause no. 10 of IS: 15086, Part-4:2017.

7.1 ~~Power Frequency reference Voltage Test~~

~~7.1.1 This test shall be carried out at power frequency voltage and at an ambient temperature of 20±15°C. The reference voltage shall be measured at defined current at the knee of the current voltage characteristic of the arrester. The crest value of the resistive component of the above defined arrester current shall be in the range of 1 to 20mA, depending on the nominal discharge current and/or long duration discharge class of the arrester.~~

~~7.1.2 In addition, the resistive and capacitive component of the leakage current shall be measured at continuous operating voltage.~~

7.2 ~~Residual Voltage Test~~

~~The test shall be made on three samples of complete arrester or arrester sections. The time between discharge must be sufficient to permit the sample to return to approximately ambient temperature. The maximum envelope of the points shall be drawn in a residual voltage/discharge current value.~~

~~7.2.1 Steep Current Impulse Residual Voltage Test~~

~~A current impulse with 01 microsecond virtual front time shall be used with limits in the adjustments of equipment of ±10%. The virtual time to half value on the tail shall be not longer than 20 micro second. One current impulse with the peak value equal to the nominal discharge current of the arrester ±5% shall be applied to each sample.~~

~~7.2.2 Lightening Impulse Residual Voltage Test~~

~~A 8/20 current impulse shall be used with limits on the adjustments of equipment such that the measured values are from 7 micro second to 9 micro second for the virtual front time and from 18 micro seconds to 22 microseconds for the time to half value on the tail. Three current impulses shall be applied to each sample with peak values of approximately 0.5, 1.0 and 2.0 times the nominal discharge current of the arrester.~~

~~7.2.3 Switching Impulse Residual Voltage Test~~

~~Two current impulses of approximately 250 and 1000Amps (peak)±5% having a virtual front time greater than 30 microseconds but less than 100micro seconds, and a virtual time to half value on the of roughly twice the virtual front time shall be applied to each of the three samples.~~

7.3 ~~Long Duration Current Impulse Withstand Test~~

This test shall be carried out on three new samples of complete arresters, arrester sections or resistor elements, as per clause no. 59.1.2 of IEC-TC 37 W January 1987 (Draft)G. The rated voltage of the test sample shall be at least 3kV and need not exceed 6kV. The test shall consist of 18 discharge operations divided into six groups of 3 operations. Interval between operations shall be 50 to 60 seconds and between groups such that the device cools to near ambient temperature.

7.4 Operation duty tests

The test shall be made on three samples of complete arresters or arrester sections. The rated voltage of the test samples shall be at least 3kV and not exceed 12kV. The power frequency test voltage to be applied to the test arrester section shall be voltage of the complete arrester divided by the total number of similar arrester sections.

7.4.1 Accelerated Ageing Test

This test procedure is designed to determine the voltage values of U_{C*} and U_{R*} used in the operating duty tests (see annexure-B), which will allow those tests to be carried out on new resistors.

7.4.1.1 Test procedure:

(a) Three resistor samples shall be stressed at a voltage equal to the continuous operating voltage of the sample for 1000 hours, during which the temperature shall be controlled to keep the surface temperature of the resister at 115±4°C.

(b) During the accelerated ageing the resistor may be in the surrounding medium used in the arrester. In this case, the procedure shall be carried out on single resistors in a closed chamber where the volume of the chamber is at least twice the volume of the resister and where the density of the medium in the chamber is not less than the density of the medium in the arrester.

(c) If the manufacturer can prove that this procedure carried out in open air is equivalent to the procedure carried out according to the above paragraph, then the procedure can be carried out in open air.

(d) The relevant voltage for this procedure is the corrected maximum continuous operating voltage (U_{CT}) which the resisters must support in the arrester including voltage unbalance effects. This voltage should be determined form the formula:

$U_{CT} = U_C (1+0.03L)$

Where L is the total length of the arrester in meters and U_C is the continuous operating voltage of the arrester.

(e) The ageing procedure described above shall be carried out on 3 typical samples of resistor elements.

7.4.1.2 Determination of elevated rated and continuous operating voltages.

(a) The three test samples shall be heated to 115±4°C and the resistor power losses P_{1CT} shall be measured at a voltage U_{CT}, 1 to 2 hours after the voltage application. The resister power losses P_{2CT} shall be measured after 1000h (0 +100h) of ageing under the same conditions without intermediate de-energizing of the test samples. Within the temperature range allowed both measurements shall be made at the same temperature ±1°C.

(b) If P_{2CT} is greater than P_{1CT} the ratio $K_{CT} = P_{2CT}/ P_{1CT}$ is determined for each sample. In such case, when testing for the operating duty tests the continuous operating voltage U_C and the rated voltage U_R shall be increated to U_{C*} and U_{R*} respectively, in order to match the increase of power losses due to ageing. If P_{2CT} is equal or less than P_{1CT}, U_C and U_R should be used without any correction. U_{C*} and U_{R*} are the highest of three values respectively, determined in the following way :

On three new resistors at ambient temperature the power losses P_{1C} and P_{1R} shall be measured at U_C and U_R respectively.

Thereafter the voltages shall be increased to U_{C*} and U_{R*} so that the corresponding power losses P_{2C} and P_{2R} fulfill the relation:

$P_{2C}/P_{1C} = K_{CT} : P_{2R}/P_{1R} = K_{CT}$

Where K_{CT} is the biggest of the three power loss ratios determined in the ageing test.

The measuring time should be short enough to avoid increased power loss due to heating.

7.4.2 Heat Dissipation Behavior of Test Samples

The test sample shall meet the requirements of clause no. 60.3 of IEC TC 37 WG 4 (Draft) January 1987 8.4 of IS: 15086 (Part 4):2017.

7.4.3 Switching surge operating duty test:

7.4.3.1 General

Before the switching surge operating duty test, the lightening impulse residual voltage at nominal discharge current of each three test sample (resister elements) shall be determined at ambient temperature.

Thereafter, the samples shall be exposed to a conditioning test consisting of twenty current impulses with a time interval between the impulses of 50 to 60 seconds and having an 8/20 impulses shape and a first part of the conditioning may be carried out of the resister elements in open air at a still air temperature of 20±15°C. This is followed by two high current impulses of 65kA, 4/10 microsecond impulse shape. The measured peak value of the current impulses shall be within 90% and 110% of specified peak value. After this conditioning the sections are stored for future use in the switching surge operating duty test (Annexure-B).

7.4.3.2 Test Procedure

At the beginning of the switching surge operating duty test the temperature of the complete section shall be 60±3°C.

The arrester shall be subjected to two long duration current impulses as specified in clause 6.3. The time interval between the impulses shall be 50 to 60 seconds. The conditioning impulses and the long duration current impulses shall be applied with the same polarity.

After the second long duration impulses the section shall be disconnected from the line and connected to the power frequency source instantly, but the later than 100miliseconds after the impulse. The corrected rated voltage (U_R) and the corrected continuous operating voltage (U_C) determined from the accelerated ageing procedure described shall be applied for a time period of 10 seconds and 30 minutes respectively to prove thermal stability or thermal run away.

No linear metal oxide resistor temperature or resistive component of current or power dissipation shall be monitored during the power frequency voltage application to prove thermal stability thermal run away.

Oscillographic records of the voltage across and current through the test sample shall be made at the second long duration current impulse. The energy dissipated by the test sample during the second operation shall be determined from the voltage and current oscillograms and the energy value shall be determined from the voltage and current report. The current and voltage shall be registered continuously during the power frequency voltage application.

Following the complete test sequence and after the test sample has cooled to near ambient temperature, the residual voltage tests which were made at the beginning of the test sequence, shall be repeated. The complete test sequence is illustrated in Annexure-B.

The arrester has passed the test if thermal stability is achieved (ref:6.4.4), if the change in residual voltage measured before and after the test is not changed by more than 5% and if examination of the test sample after the test reveals no evidence of puncture, flashover or crack of the nonlinear metal oxide arrestors.

7.4.4 Evaluation of Thermal Stability in Operating Duty Test

The arrester sections subjected to the operating duty tests are considered to be thermally stable and pass the test if the peak of the resistive component of the leakage current or power dissipation or resistor temperature is stabilized or steadily decreases at least during the last part of the 30 minutes of U_{c*} voltage applied in the procedure shown in Annexure-B.

7.4.5 Power Frequency Voltage versus Time Characteristics of Arrester

The manufacturer vendor shall furnish the information as required by clause 60.7 of IEC TC 37WG 4 January 1987 (Draft) 8.8 of IS: 15086 (Part 4):2017.

7.4.6 Pressure relief test

This test shall be carried out as per clause no. 7.11 of IS 3070 9Part-I).

7.4.7 Artificial pollution test:

This test is made to show that the temperature rise of the non linear metal oxide resister elements of the arrester does not exceed the value on which the operating duty tests are based on which the specified life performance characteristics of the arrester are based.
The salt fog/solid layer method prescribed in IS: 8704 1978 shall be adopted for carrying out this test.

The testing procedure is as follows:
The complete arrester shall be energized at its continuous operating voltage. At different salinities which correspond to non-significant pollution, light pollution, heavy pollution and very heavy pollution) refer IS: 3716-1976- Table-2), the steady state temperature on the nonlinear metal oxide resistors at different points of the arrester shall be measured.

The temperature on the non-linear metal oxide resistances may be measured by thermocouples through holes in the arrester housing that may to a negligible extent change the conditions of heat dissipation from the resistors. Alternatively, the temperature on the non linear metal oxide resisters can be registered with temperature sensitive tape built in on the resistor assembly.

7.4.8 Insulation withstand test;

This test demonstrate the voltage withstand capability of the external insulation of the separately housed arresters.

7.4.8.1 Lightening Impulse Voltage Test

Fifteen consecutive impulses at the test voltage value shall be applied for each polarity. The arrester shall be considered to have passed the test if no internal disruptive discharge occurs and if the number of the external disruptive discharge does not exceed two for each series of 15 impulses.

7.4.8.2 Power Frequency Voltage test:

This test shall be carried out as per clause 7.5 of IS: 3070 (Part-I).

7.4.9 Other miscellaneous Tests:

~~7.4.9.1 Galvanizing Test on metal parts:~~

~~3 samples of the cut pieces of galvanized component shall be tested confirming to RDSO specification no. ETI/OHE/13 (4/84).~~

~~7.4.9.2 Porosity test on Porcelain components:~~

~~This test shall be carried out as per clause 7.14 of IS: 3070 (Part-I).~~

~~7.4.9.3 Temperature cycle test on porcelain housing:~~

~~This test shall be carried out as per clause 7.13 of IS: 3070 (Part-I).~~

~~7.4.9.4 Visual examination of Porcelain housing~~

~~This test shall be carried out as per clause 7.16 of IS: 3070 (Part-I).~~

8.0 Before giving the call to CORE ~~RDSO~~/The Chief Electrical Engineer for inspection and testing of the prototype of the system, the manufacturer shall submit a detailed test schedule consisting of schematic circuit diagrams for each of the test and nature of the test, venue of the test and the duration of each test and the total number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, CORE ~~RDSO~~ representative reserves the right to conduct any additional test(s), besides those specified herein, on any equipment/item so as to test the equipment/item to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the ~~manufacturer~~ vendor and CORE ~~RDSO/~~the Chief Electrical Engineer during the process of testing as regards Lucknow during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the ~~Director General (Traction Installation~~), ~~RDSO/~~CORE/the Chief Electrical Engineer as the case may be whose decision shall be final and binding.

9.0 Bulk manufacturing of the lightening arrester shall be taken up only after specific written approval is given by the ~~purchaser/~~CORE to the ~~successful tenderer~~ vendor on the basis of the tests conducted on the prototype unit manufactured according approved design and drawings.

10.0 Acceptance Tests

Following are the tests which are to be conducted at the time of acceptance of the Lightening Arrester.

10.1 Measurement of Power Frequency Reference Voltage.

10.2 Lightening Impulse Residual Voltage on the completer arrester or arrester unit at nominal Discharge Currents if possible or at current value in the range of 0.01 to 0.25 times nominal discharge current of the lightening arrester.

10.3 Partial Discharge Test: The Power Frequency Voltage applied to the Arrestor shall be increased up to its rated voltage and after less than 10 seconds decreased to 1.05 times its 'Continuous Operating Voltage'. At that voltage the partial discharge level according to IEC Publ.270 shall be measured. The measured value shall not exceed 50pc.

10.4 Measurement of IR values of the Lightening Arrester and it should be greater than 10Gohm.

11.0 Routine Tests

(i) Visual examination.

(ii) Measurement of Power Frequency Reference Voltage.

(iii) Lightening Impulse Residual Voltage on the completer arrester, assembled arrester unit on or single or several register elements at a suitable lightening impulse current in the range between 0.01 to 0.2 times nominal current at which the residual voltage is measured.

(iv) Measurement of Leakage Current at Continuous Operating Voltage.

(v) Satisfactory absence from 'Partial Discharges' and 'Contact Noise' by any sensitive method.

(vi) Leakage check by any sensitive method to see the efficacy of the sealing system.

12.0 Tests on Surge Monitor and Insulating Base

While carrying out the prototype tests on the lightning arrester, following tests shall also be done on the surge monitor and insulating base.

12.1 Surge Monitor

i) Tests for satisfactory operation of 'Surge Counter' while discharging surges.

ii) Tests for correctness of 'Leakage Current Meter' before and after the passage of surges.

iii) Visual Examination.

12.2 The above tests shall also form part of the routine tests.

12.3 Insulating Base

On the prototype insulating base, all tests stipulated vide clause 8.5.9 above shall be carried out. During routine tests, only visual examination of the insulating base shall be done.

13.0 Technical Data and Drawings

13.1 The ~~Tenderer~~ vender shall indicate his compliance or otherwise against each clause and sub-clause of the Technical Specification. The ~~Tenderer~~ vender shall for this purpose enclose a separate statement, if necessary, indicating the clause reference and compliance or otherwise. Wherever the offer of the ~~Tenderer~~ vender deviates from the provisions of the clauses, they shall furnish their detailed remarks.

13.2 The ~~Tenderer~~ vender shall furnish Guaranteed Performance data, Technical and other Particulars for the Lightening Arrester in the proforma attached as Annexure-A. The information furnished in 'Schedule of Guaranteed Technical Performance Data' and other Particulars shall be complete in all respects. If there is any entry like "shall be furnished later" or blanks are left against any item, the ~~tender~~ Guaranteed Performance data is not likely to be considered. ~~as such omissions causes delays in finishing tender.~~

13.3 Drawings showing the overall dimensions of the Lightening Arrester, a cross-sectional view indicating non-linear Resistor Blocks, Retainer arrangement, Terminal details, method connecting high tension & earthing leads, mounting arrangements and evidence in the form of Prototype Test reports for the Arrester, if available, shall be submitted along with the Tender.

13.4 The ~~successful Tenderer~~ vendor shall be required to submit the above mentioned detailed Dimension Drawings for approval and shall also furnish six copies of the approved Drawings, ~~as per Railway standards. (Standard proforma enclosed as Appendix IV)~~

13.5 The ~~successful Tenderer~~ vendor shall also submit the copies of Technical Booklets, Information Manuals, and Test Reports etc.

14.0 ~~Technical collaboration and indigenisation~~

~~Progressive indigenisation of Lightening Arrestors, covered by this Specification is contemplated. Design calculations, detailed manufacturing process and all relevant information pertaining to transfer of technical know-how in this regard shall be carried out in such a manner between the overseas manufacturer and the Indian manufacturer as to ensure that the indigenous content of the Lighting Arrester made in India increases~~

~~progressively and rapidly without sacrificing quality and reliability. Research Designs & Standards Organisation of the Indian Railways is to be associated at various stages of indigenisation so as to take into account service experience while attempting progressive indigenization.~~

~~The information exchanged between the overseas manufacturer and the Indian manufacturer is not ordinarily required to be passed on to the Indian Railways. However, the authorised representative of the Indian Railways shall have access to the above information at the manufacturer's works, overseas or the manufacturer's works/Design office in India, whenever it becomes necessary for the purpose of inspection and acceptance of the product at the manufacturer's works or for the purpose of analysis/investigation for overcoming difficulties and problems and for improving the performance reliability in service.~~

15.0 Warranty

15.1 All lightening arresters supplied against this contract irrespective of origin (imported/indigenous) shall be guaranteed for trouble free and satisfactory performance for a period of 24 months from the date of supply of 18 months from the date of commissioning, whichever is earlier. Details of warranty clause, the extent of responsibility on the apart of the supplier and other relevant aspects will be included in the contract. The ~~tenderer~~ vendor may furnish his detailed terms in this regard in his offer.

15.2 The ~~Supplier~~ vendor shall make necessary arrangements for close monitoring of performance of Lightening Arresters, thorough periodical visits to Traction Sub-stations/Switching Stations for observations.

15.3 Technical guidance and assistance for proper operation and maintenance, trouble-shooting investigation and generally all aspects of technical liaison that may be required, shall also be organised by the ~~supplier~~ vendor.

ANNEXURE-A

SCHEDULE OF GUARANTEED PERFORMANCE –
TECHNICAL AND OTHER PARTICULARS

Sl. No.	Description			Unit of Measurement
1.	Name of Manufacturer			
2.	Country of origin			
3.	Standard Specification on which performance is based			
4.	Manufacturer's Type Designation			
5.	Rated Voltage (RMS)			kV
6.	Rated Frequency			Hz
7.	Continuous Operating Voltage			kV
8.	Watt-loss at Continuous Operating Voltage			Watt/kV
9.	Watt-loss at Rated Voltage			Watt/kV
10.	Leakage current at Continuous Operating Voltage			mA
11.	Leakage Current at Rated Voltage			mA
12.	Rated Voltage of the Section (Metal Oxide Disc)			kV
13.	Maximum Power Frequency Reference Voltage of the Section			kV
14.	Minimum Power Frequency Reference Voltage of the Section			kV
15.	Nominal Discharge Current (8/20 µs wave)			kA
16.	Residual Voltage	At 0.5 times Nominal Discharge Current		kV (Peak)
		At Nominal Discharge Current		kV (Peak)
		At twice the Nominal Discharge Current		kV (Peak)
17.	Switching Impulse Residual Voltage Test with 45/90 µs Current wave of 250 Amps and 1000 Amps.			kVp
18.	Steep Current Impulse Residual Voltage with 1.0 µs Front time & Current wave of 10 kA_{peak}.			kVp
19.	High Current Impulse withstand (4/10 µs wave)			kAp
20.	Long duration Current Impulse Rating	Peak current		A
		Virtual Duration of peak		µs
		Line Discharge class of the Arrestor		
21.	Power Frequency Voltage Withstand of Arrester Insulation (RMS)		Dry	kV
			wet	kV
22.	Lightening Impulse Withstand Voltage of Arrester			kVp
23.	Type of non-linear Resistor Disc, size (Diameter, Height) and Voltage rating			kV
24.	Number of non-linear Discs per Section of Arrester.			Nos.
25.	Number of sections in one arrester.			Nos.
26.	Material of Retainer used inside Lightening Arrester Bakelite, Ceramic, Rubber or other material			
27.	Is Pressure Relief Device provided, if so, it's class?			
28.	Overall Dimensions	Height		mm
		Diameter		mm
29.	Net weight			Kg.
30.	Mounting Base	No. of holes		No.
		Diameter of holes		mm
		Pitch circle diameter		mm
31.	Temporary Over Voltage capability for	0.1 second		kV_{rms}
		1.0 second		kV_{rms}
		10.0 second		kV_{rms}
32.	Surge Monitor			
	(i) Make			
	(ii) Model			
	(iii) Type			

	(iv) Sensitivity of Surge Counter (Minimum current at which the Counter operates)	
	(v) Nominal discharge current	
	(vi) Max. current to be withstood by the surge monitor	
	(vii) Counter operation	
	(viii) Safe leakage current indication	
	(ix) Indication of deterioration of surge arrester	
	(x) Net weight	
33.	Are the live and earth ends of Arrester suitable for Jumper/ Flats as specified?	
34.	Are grading rings provided?	
35.	Voltage-Current Characteristic Curves of the Zinc Oxide Element at different temperatures	
36.	Any other Technical data, the Manufacturer may like to furnish	

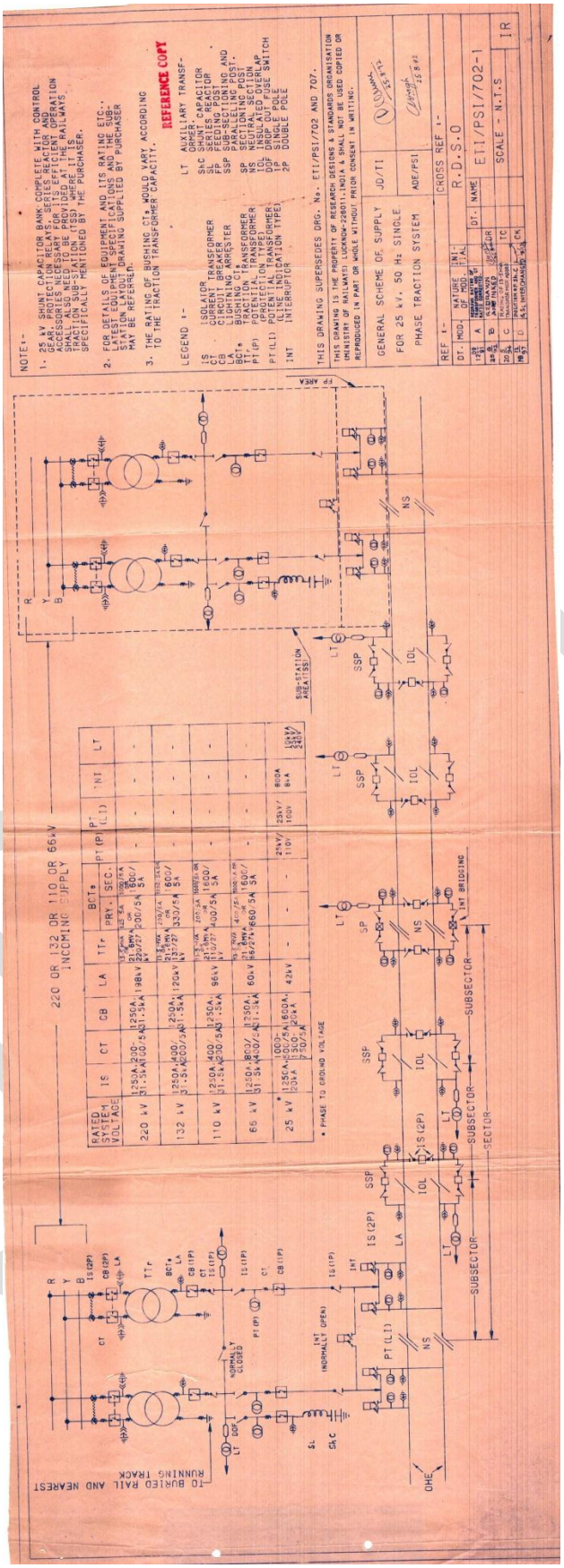
~~ANNEXURE-B~~

~~Operating Duty testy for 10,000A arresters line discharge class 3 and clause 8.5~~

~~Conditioning~~	~~Residual voltage Measurement at In.8/20~~	~~1 X In 8/20~~
	~~Time Interval not Specified~~	
	~~Conditioning Test 20 Imp. At In. 8/20 1 minute interval~~	~~20 X In 8/20~~
	~~Time Interval not Specified~~	
	~~High current impulse conditioning on sections.~~ ~~Cooling to ambient temperature~~ ~~High current impulse conditioning on sections~~	~~2X65kA 4/10~~
	~~Hold for future use~~	
~~Switching surge Operating duty test~~	~~Cool to or preheat to 60±3°C~~	
	~~Long Duration current Impulse~~	
	~~As short as possible not longer than 100 milliseconds~~	
	~~Rated Voltage 10 seconds~~	~~U_{p*}~~
	~~Continuous operating voltage 30 minutes~~	~~U_{c*}~~
	~~Cool to ambient, 25±10°C~~	
	~~Residual Voltage measured at In.8/20~~	~~1 X In 8/20~~
	~~Examination of test sample~~	

~~In = Nominal Discharge Current~~

ANNEXURE-C


REFERENCE COPY
NOTE:-
1. 25 kV SHUNT CAPACITOR BANK COMPLETE WITH CONTROL GEAR, PROTECTION RELAYS, SERIES REACTOR ETC. IF REQUIRED FOR SATISFACTORY OPERATION ACCESSORIES NEED NOT BE PROVIDED AT THE RAILWAYS TRACTION SUB-STATION (TSS) WHERE SPECIFICALLY MENTIONED BY THE PURCHASER.
2. FOR DETAILS OF EQUIPMENT AND ITS RATING ETC., LATEST EQUIPMENT SPECIFICATIONS AND THE USER STATION LAYOUT DRAWING SUPPLIED BY PURCHASER MAY BE REFERRED.
3. THE RATING OF BUSHING CTs WOULD VARY ACCORDING TO THE TRACTION TRANSFORMER CAPACITY.
LEGEND :-
IS ISOLATOR
CT CURRENT TRANSFORMER
CB CIRCUIT BREAKER
LA LIGHTNING ARRESTER
BCT* BUSHING CT
TTr TRACTION TRANSFORMER
PT(P) POTENTIAL TRANSFORMER (PROTECTION TYPE)
PT(LI) POTENTIAL TRANSFORMER (LINE INDICATION TYPE)
INT INTERRUPTOR
LT AUXILLARY TRANSFORMER
SHC SHUNT CAPACITOR
PI PANTOGRAPH ISOLATOR
SSP SUB-SECTIONING AND PARALLELING POST
SP SECTIONING POST
NS NEUTRAL SECTION
IOL INSULATED OVERLAP
DDF DROP OUT FUSE SWITCH
1P SINGLE POLE
2P DOUBLE POLE
THIS DRAWING SUPERSEDES DRG. No. ETI/PSI/702 AND 707.
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GENERAL SCHEME OF SUPPLY
FOR 25 kV, 50 Hz SINGLE PHASE TRACTION SYSTEM
JD/TI
ADE/PSI
CROSS REF :-
R.D.S.O
ETI/PSI/702-1
SCALE - N.T.S
IR
220 OR 132 OR 110 OR 66kV INCOMING SUPPLY
FAULT LEVEL
RATED SYSTEM VOLTAGE
IS
CT
CB
LA
TTr
BCT*
PRI.
SEC.
PT (P)
PT (LI)
INT
LT
220 kV
132 kV
110 kV
66 kV
25 kV
* PHASE TO GROUND VOLTAGE
TO BURIED RAIL AND NEAREST RUNNING TRACK
OHE
NORMALLY CLOSED
INT BRIDGING
SUBSECTOR
SECTOR
SUBSTATION AREA (SSI)
FP AREA