

Standard Specification  
for  
Surge Arrester

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## 1.0 GENERAL REQUIREMENT

- 1.1. The Surge arrester shall conform to IEC 60099-4 (latest edition) except to the extent modified in the specification and shall also be in accordance with requirements under Section -GTR.
- 1.2. The Surge Arrester shall be designed for use in the geographic and meteorological conditions as given in Section-GTR and Section- Project

## 2.0 DUTY REQUIREMENTS

- 2.1 The surge arrester shall be of **Station High Duty (SH) / Station Medium Duty (SM) / Station Low Duty (SL)** as per requirement and gapless type without any series or shunt gaps.
- 2.2 The surge arrester shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.
- 2.3 420 kV class Surge arresters shall be capable of discharging severe re- energization switching surges on a 400kV, 450km long line with Surge impedance of 300 ohms and capacitance of 11.986nF/km and over voltage factor of 2.3 pu.

Similarly, 800kV class Surge arresters shall be capable of discharging severe re- energization switching surges on a 765kV, 450km line with Surge impedance of 270 ohms and capacitance of 13 nF/km.

- 2.4 420kV class arrester shall be capable of discharging energy equivalent to Station High Duty (SH) class of IEC with thermal energy (Wth) of minimum 12kJ/kV for a 420kV system followed immediately by 50 Hz energization with a sequential voltage profile as specified below:

650 kVp for 3 peaks

575 kVp for 0.1 second

550 kVp for 1 second

475 kVp for 10 seconds

800kV class arrester shall be capable of discharging energy equivalent to Station High Duty (SH) class of IEC with thermal energy (Wth) of minimum 13 kJ/kV for an 800kV system followed immediately by 50 Hz energization with a sequential voltage profile as specified below:

1000 kVp for 3 peaks

910 kVp for 0.1 second

885 kVp for 1 second

866 kVp for 10 seconds

- 2.5 245/145 kV class arrester shall be capable for discharging energy equivalent to Station Medium Duty (SM) class of IEC with thermal energy (Wth) of minimum 7 kJ/kV for

245/145 kV system followed by procedure as per IEC.

- 2.6 The surge arrester shall be suitable for withstanding forces as defined in Section- GTR.
- 2.7 The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 2.8 The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below: -

Equipment to be protected	800 kV system		420 kV system		245kV system	145kV system
	Lightning Impulse (kVp)	Switching surge(kV)	Lightning impulse(kVp)	Switching surge(kV)	Lightning impulse (kVp)	Lightning Surge (kVp)
Power Transformer	$\pm 1950$	$\pm 1550$	$\pm 1300$	$\pm 1050$	$\pm 950$	$\pm 550$
Reactor	$\pm 1950$	$\pm 1550$	$\pm 1300$	$\pm 1050$	$\pm 950$	$\pm 550$
Instrument Transformer	$\pm 2100$	$\pm 1550$	$\pm 1425$	$\pm 1050$	$\pm 1050$	$\pm 650$
CB/Isolator Phase to ground	$\pm 2100$	$\pm 1550$	$\pm 1425$	$\pm 1050$	$\pm 1050$	$\pm 650$
CB/Isolator Across open contacts	$\pm 2100 (-/+455)$	$\pm 1175 (-/+650)$	$\pm 1425 (-/+240)$	$\pm 900 (-/+345)$	$\pm 1050$ (for CB) $\pm 1200$ (for Isolator)	$\pm 750$ (for Isolator)

- 2.9 The duty cycle of CB installed in 800/420/245/145 kV System of the Employer shall be O-0.3 sec-CO-3 min-CO. The Surge Arrester shall be suitable for such circuit breaker duties in the system.

### 3.0 CONSTRUCTION FEATURES

The features and constructional details of surge arrester shall be in accordance with requirements stipulated hereunder:

- 3.1 The non-linear blocks shall be of sintered metal oxide material and shall be provided in a way as to obtain robust construction with excellent mechanical and electrical properties even after repeated operations.
- 3.2 The surge arrester offered shall be of Design A (for 336kV and above voltage level) and Design A/Design B for below voltage rating.
  - a. **Design A type arrester must be fitted with pressure relief devices** suitable for preventing violent failure of insulator housing and providing path for flow of rated fault currents in the event of arrester failure.
  - b. Design B arrester should be embedded all the components free of bubbles and gaps thus preventing partial discharge and moisture ingress. This type of design must have the ability to control the cracking or tearing open of housing due to arc action and thereby avoiding violent shattering.
- 3.3 The outer insulator of surge arrester shall be porcelain/polymer conforming to requirements stipulated in Section-GTR. Terminal connectors shall conform to requirements stipulated under Section-GTR. The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to

- the maximum design value for arrester. Arresters shall not fail due to arrester insulator contamination.
- 3.4 Seals (for design A arresters) shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.
- 3.5 The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.
- 3.6 The name plate shall conform to the requirements of IEC incorporating the year of manufacture.
- 3.7 The following details shall be furnished for quality checks:
- The heat treatment cycle details along with necessary quality checks used for individual blocks and insulation layer formed across each block.
  - Metalizing coating thickness for reduced resistance between adjacent discs.
- 3.8 **The manufacturer will submit data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.**
- 3.9 The sealing arrangement (for design A arresters) of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.
- 3.10 Arresters shall be of hermetically sealed units, self-supporting construction, suitable for mounting on tubular/lattice support structures.
- 3.11 **For 624kV Surge arresters, the number of stacks shall be three (3). The FRP tube outer diameter shall be 300mm (min) and FRP tube thickness shall be 25mm (min).**

#### 4.0 FITTING AND ACCESSORIES

- 4.1 Arresters shall be complete with an insulating base having provision for bolting to flat surface of structure.
- 4.2 Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection arrangement. Suitable leakage current meters should also be provided. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with the minimum possible bends.
- 4.3 Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for **IP66 degree of protection**. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard insulating mounting pad. Also, all nuts, bolts, washers etc. required for fixing the surge monitor shall be supplied by the Contractor. The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. **Connection between the Surge Arrester base and Surge Monitor shall be through minimum 2.0m long insulated copper rod/strip of at least 75 mm<sup>2</sup> cross sectional area or PVC insulated flexible copper cable of at least 70 mm<sup>2</sup>.** The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.

- 4.4 Grading/corona rings shall be provided on each complete arrester unit, as required. Suitable terminal connectors shall be supplied by the Contractor.

## 5.0 TESTS

- 5.1 In accordance with the requirements stipulated under Section-GTR, the surge arresters should have been type tested as per the latest IEC/IS and shall be subjected to routine and acceptance tests in accordance with latest IEC/IS.

- 5.2 Test reports for all type tests as per latest IEC 60099-4 including following additional type tests shall also be submitted for the Employer's review:

- a. **Seismic withstand test** as per Annexure-II of Section-GTR.
- b. **Corona Extinction Voltage test** as per Annexure-I of Section-GTR.
- c. **Cantilever test** on complete arrester as per requirement of Annexure-I.

## 5.3 Acceptance Tests:

- a. Measurement of power frequency reference voltage on the arrester.
- b. Lightning Impulse Residual voltage on arrester.
- c. Internal partial Discharge test.

## 5.4 Special Acceptance Test:

- a. **Thermal stability test** on three sections as per Clause 9.2.2 of relevant IEC.
- b. **Aging test** for Zinc oxide blocks is to be carried out on 3 samples for 72 hours at maximum continuous over voltage (MCOV) and at a temperature of 115°C. Acceptance criteria is Ir (resistive current)/watt loss shall remain or decrease at the end of 72 hrs from the value taken after 1 hour of start of test.
- c. Watt loss test.

## 5.5 Routine Tests:

- a. Measurement of Reference voltage
- b. Residual voltage test.
- c. Internal partial discharge test.
- d. Verticality checks on completely assembled surge arresters as a sample test on each lot.
- e. **Sealing test:** Water dip test at 1.5m depth from top of Surge Arrester for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e. PD Measurement, Reference Voltage, Residual Voltage & IR measurement).

## 5.6 Routine Tests on Surge Monitor:

- a. The Surge monitors shall be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.
- b. Surge monitors shall be routinely tested for water dip test at 1.5m depth for 30 minutes.

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No water vapours shall be visible on the monitor glass.

#### **5.7 Routine Tests on insulator**

All routine tests shall be conducted on the hollow column insulators as per IEC 62155.  
Polymer housing shall be tested in accordance to IEC 61462.

#### **6.0 PRE-COMMISSIONING TESTS**

An indicative list of tests is given below. For pre-commissioning procedures and formats for Surge Arrester, Employer's Standard pre-commissioning document will be the reference document and shall be provided during detailed engineering.

Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates at his own cost.

- a. Operation check of LA counter
- b. Insulation resistance measurement
- c. Capacitance and Tan delta measurement of individual stacks
- d. Third harmonic resistive current measurement (to be conducted after energization)

## 7.0 TECHNICAL PARAMETERS

### 7.1 Technical Parameters for 765kV, 400kV, 220kV and 132kV Surge Arresters (with Polymer/Porcelain Housing)

S. No.	Description	Unit	800kV SA	420kV SA	245kV SA	145kV SA
1	Nominal System Operating voltage	kV <sub>rms</sub>	765	400	220	132
2	Rated frequency	Hz	50			
3	No. of Poles	No.	1			
4	Design ambient temperature	°C	50			
5	Rated arrester voltage	kV	624	336	216	120
6	Continuous operating voltage at 50°C	kV	490	267	168	102
7	Nominal discharge current	kA	20 kA of 8/20 μS wave	20 kA of 8/20 μS wave	10 kA of 8/20 μS wave	10 kA of 8/20 μS wave
8	Discharge current at which insulation co-ordination will be done	kA	20 kA of 8/20 μS wave	20 kA of 8/20 μS wave	10 kA of 8/20 μS wave	10 kA of 8/20 μS wave
9	Rated thermal energy rating of rated arrester voltage	kJ/kV	13kJ/kV	12kJ/kV	7kJ/kV	7kJ/kV
10	Repetitive charge transfer rating Qrs in coulombs	C	3.6C	2.4C	1.6C	1.6C
11	Max. switching surge residual voltage	kVp	1180 (at 1kA) 1220 (at 2kA)	650 (at 500A) 670 (at 2kA)	500 (at 1kA)	280 (at 1kA)
12	<b>Max. residual voltage at</b>					
i)	5kA	kVp	-	-	560	310
ii)	10kA nominal discharge current	kVp	-	800	600	330
iii)	20kA nominal discharge current	kVp	1480	850	-	-
iv)	Steep fronted wave residual voltage at 20 kA	kVp	1650	925	-	-
13	Arrester classification		Station High duty (SH)		Station Medium duty (SM)	
14	High current short duration test value (4/10 micro second wave)	kAp	100	100	100	100
15	Current for pressure relief test	kA rms	63	63	50	40
16	Low current long duration test value	As per IEC				
17	<b>Insulation Level</b>					
a)	<b>Full wave impulse withstand voltage (1.2/50 microsec.)</b>					
i)	Arrester Housing	kVp	As per IEC 60099-4			
b)	<b>Switching impulse withstand voltage (250/2500 micro-second) dry/wet</b>					
i)	Arrester Housing	kVp	As per IEC 60099-4		-NA-	-NA-
c)	<b>One minute power frequency dry/wet withstand voltage</b>					
i)	Arrester Housing	kV rms	-NA-	-NA-	As per IEC:60099-4	
18	Max. radio interference voltage for frequency between 0.5 MHz and 2MHz. in all positions	μV	2500 at 508kV <sub>rms</sub>	500 at 266kV <sub>rms</sub>	500 at 156kV <sub>rms</sub>	500 at 92kV <sub>rms</sub>
19	Minimum Creepage distance	mm	As per Section-GTR			
20	Cantilever Strength (for 1 minute withstand test)	kg	500	350	150	150
21	Maximum deflection at above cantilever load	mm	200	200	125	50



22	Seismic acceleration		As per IS:1893	---	---
23	Partial Discharge at 1.05 COV		$\leq 10\text{pC}$		
24	System neutral earthing		Effectively Earthed		

Note: The above insulation levels are applicable for altitude up to 1000 meters above M.S.L. For higher altitudes, suitable correction factor as per relevant IEC shall be applied.

## 7.2 Technical parameters for 72.5kV, 36 kV and 11 kV Surge Arresters (with Porcelain /Polymer Housing)

S. No.	Description	Unit	72.5kV SA	36kV SA	12kV SA
1	Nominal System Operating voltage	kV <sub>rms</sub>	66kV	33kV	11kV
2	Rated frequency	Hz	50		
3	No. of Poles	No.	1		
4	Design ambient temperature	°C	50		
5	Rated arrester voltage	kV	60	30	9
6	Continuous operating voltage at 50 °C	kV <sub>rms</sub>	51	25	7.2
7	Nominal discharge current	kA	10 kA of 8/20 microsecond wave		
8	Discharge current at which insulation co- ordination will be done	kA	10 kA of 8/20 microsecond wave		
9	Rated thermal energy rating Wth of rated arrester voltage	kJ/kV	7	4	4
10	Repetitive charge transfer rating Qrs in coulombs	C	1.6	1	1
11	Max. switching surge residual voltage	kVp	136 (at 1kA)	72 (at 1kA)	22.4 (at 1kA)
12	Max. residual voltage at				
i)	5kA	kVp	160	85	26
ii)	10 kA nominal discharge current	kVp	170	90	28
iii)	20 kA nominal discharge current	kVp	190	-	--
iv)	Steep fronted wave residual voltage at 10 kA	kVp	190	-	--
13	Arrester designation		Station Medium duty (SM)	Station Low duty (SL)	Station Low duty (SL)
14	High current short duration test value (4/10 micro second wave)	kA <sub>rms</sub>	100	100	100
15	Current for pressure relief test	kAp	40	25	25
16	Low current long duration test value		As per IEC		
17	Insulation Level				
a)	Full wave impulse withstand voltage (1.2/50 microsec.)				
i)	Arrester Housing	kVp	As per IEC 60099-4		
b)	One minute power frequency dry/wet withstand voltage				
i)	Arrester Housing	kV <sub>rms</sub>	As per IEC 60099-4		
18	Minimum Creepage distance	mm	As per Section-GTR		
19	Cantilever Strength (for 1 minute withstand test)	kg	150	150	150
20	Maximum deflection at above cantilever load	mm	20	20	20

Note: The above insulation levels are applicable for altitude up to 1000 meters above M.S.L. For higher altitudes, suitable correction factor as per relevant IEC shall be applied.