



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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1 Scope, Quantities and Specific Technical Requirements

1.1 Scope

This technical specification covers the requirements of design, manufacture, testing at works, packing, loading at works and transport to *site* of metal oxide gapless type arresters complete with all accessories such as insulating base, surge monitor, HV power connector, corona grading ring (if applicable), insulated interconnecting copper rod/strip between arrester and surge monitor, nuts, bolts and washers for bolting the arrester units, fixing the surge monitor to structure, connecting the earthing, bypass shunts etc.

The equipment is required for the following project:

Name of customer : Power Grid Corporation of India Ltd (POWERGRID)

Name of the project : ±800kV, 6000MW HVDC Raigarh – Pugalur Terminals

Site : Raigarh & Pugalur

Refer section-3 of this document for project details and general specification.



1.2 Quantities

Sl. No.	Description	Location	Raigarh		Pogalur	
			Quantity # (Nos)	Item Designation*	Quantity # (Nos)	Item Designation*
1	336kV 20kA (Discharge class-4)gapless type Metal Oxide Surge arrester comprising of metal oxide elements housed in Composite Insulator with Pressure Relief arrangements and a creepage distance of 25mm/kV along with Insulating Base & Surge Monitor with a potential free contact rated for 220 Volt (DC) which shall close whenever a surge is recorded by surge monitor, and connecting lead suitable to copper rod/strip of 75 sq.mm of length 4 m and Terminal connector as per clause 2.5.2 with including fixing hardware as per Clause 2.5.4.	Line Arresters	0	NA	24	=W1.W3.F1, =W1.W5.F(1,2), =W1.W7.F2, =W1.W9.F1, =W1.W11.F(1,2), =W1.W13.F2
		ICT Arresters	0	NA	6	=W3.W4.F1, =W3.W2.F1
		Line reactor Arrester	0	NA	6	=W1.W11.F3, =W1.W13.F3
		Shunt reactor arrester	6	=W1.Z2.Z5.F1, =W1.Z5.Z5.F1	6	=W1.Z1.Z4.F1, =W1.Z4.Z5.F
		Spares	3	NA	6	NA
2	120kV 10kA (Discharge class-3)gapless type Metal Oxide Surge arrester comprising of metal oxide elements housed in Composite Insulator with Pressure Relief arrangements and a creepage distance of 25mm/kV along with Insulating Base & Surge Monitor with connecting lead suitable to copper rod/strip of 75 sq.mm of length 4 m and Terminal connector as per clause 2.5.2 with including fixing hardware as per Clause 2.5.4.	NGR	0	NA	2	=W1.W11.F4, =W1.W13.F4
		Spares	0	NA	1	NA



±800kV, 6000MW HVDC Raigarh – Pugalur Terminals

336kV, 96kV & 30kV Arresters

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Sl. No.	Description	Location	Raigarh		Pogalur	
			Quantity # (Nos)	Item Designation*	Quantity # (Nos)	Item Designation*
3	96kV 10kA (Discharge class-3)gapless type Metal Oxide Surge arrester comprising of metal oxide elements housed in <i>composite</i> Insulator with Pressure Relief arrangements and a creepage distance of 25mm/kV along with Insulating Base & Surge Monitor with connecting lead suitable to copper rod/strip of 75 sq.mm of length 4 m and Terminal connector as per clause 2.5.2 with including fixing hardware as per Clause 2.5.4.	ICT	0	NA	6	=W3.W4.F2, =W3.W2.F2
		Spares	0	NA	3	NA
4	30kV 10kA (Discharge class-2)gapless type Metal Oxide Surge arrester comprising of metal oxide elements housed in <i>composite</i> Insulator with Pressure Relief arrangements and a creepage distance of 25mm/kV along with Insulating Base & Surge Monitor with connecting lead suitable to copper rod/strip of 75 sq.mm of length 4 m and Terminal connector as per clause 2.5.2 with including fixing hardware as per Clause 2.5.4.	MVS	12	=W(4,5).F(1,2)	12	=W(4,5).F(1,2)
		VSC HVDC	0	NA	6	=W(4,5).F3
		Spares	3	NA	3	NA

*Item designation is for the purpose of name plates

Note:- Copper strip/rod shall be supplied in complete length of required for all arresters on each site separately.

Final quantity may change upto ± 30%



1.3 Specific Technical Specification

S. No.	Technical parameter	Unit	336 kV Surge arrester	120 kV Surge arrester	96 kV Surge arrester	30 kV Surge arrester	
1	Type	-	Metal Oxide, Gapless				
2	Location	-	At the terminals of Transformer/Reactor/Line	At the terminals of Reactor	At the terminals of Transformer	At the terminals of MVS	
3	Applicable standards	-	IEC 60099-4				
4	Installation	-	Outdoor				
5	Mounting	-	Structure				
6	Design Ambient Temperature	deg. C	50				
7	System Neutral Earthing		Effectively earthed				Un grounded system
8	Nominal System Voltage	kVrms	400	132	110	33	
9	Highest System Voltage	kVrms	440	145	123	36	
10	Rated Arrester Voltage	kV	336	120	96	30	
11	Rated Frequency	Hz	50	50	50	50	
12	Maximum Continuous Operating Voltage at 50 deg. C	kVrms	267	102	81	25	
13.1	Minimum Switching surge residual voltage (2kA)	kVp	670	---	---	---	
13.2	Maximum Switching surge residual voltage	kVp	650 kVp at 500 A	280 kVp at 1 kA	217 kVp at 1 kA	72 kVp at 1kA	



±800kV, 6000MW HVDC Raigarh – Pugalur Terminals

336kV, 96kV & 30kV Arresters

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S. No.	Technical parameter	Unit	336 kV Surge arrester	120 kV Surge arrester	96 kV Surge arrester	30 kV Surge arrester
14	Application		Surge protection of Transformer/Reactor/Line	Surge protection of reactor	Surge protection of transformer	Surge protection of MVS/Bus bar sys
15	Long Duration Discharge Class		4	3	3	2
16	Rated Nominal Discharge Current (8/20 μ sec.)	kAp	20	10	10	10
17	Discharge current at which insulation co-ordination shall be done		20 kA of 8/20 μ sec. wave	--	--	--
18	Pressure Relief Class	kA	63 kA at Raigarh 50 kA at Pugalur	31.5 kA	31.5 kA	25 kA
19	Minimum Energy Discharge Capability	kJ/kV	12	5	5	4
20	Minimum Creepage requirement	mm	10500	3625	3075	900
21	Rated insulation levels for arrester housing					
21.1	Lightning impulse level	kVp	1425	650	550	170
21.2	Switching surge impulse level	kVp	1050	NA	NA	NA
22	One minute power frequency withstand voltage (dry & wet)	kVrms	630	275	230	70
23	Maximum radio interference voltage for frequency between 0.5 MHz and 2 MHz	micro volts	1000 (at 266 kV rms)	500 (at 92 kV rms)	As per IEC	NA
24	Minimum prospective symmetrical fault current	kArms for 0.2 sec	63kArms at Raigarh 50 kArms at Pugalur	40	40	25



±800kV, 6000MW HVDC Raigarh – Pugalur Terminals

336kV, 96kV & 30kV Arresters

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S. No.	Technical parameter	Unit	336 kV Surge arrester	120 kV Surge arrester	96 kV Surge arrester	30 kV Surge arrester
25	Partial discharge at 1.05 COV	pC	≤ 10	≤ 10	≤ 10	≤ 10
26	Maximum residual voltage at					
26.1	5 kA nominal discharge current	kVp	-	310	256	85
26.2	10 kA nominal discharge current	kVp	800	330	272	90
26.3	20 kA nominal discharge current	kVp	850	---	304	---
26.4	Steep fronted wave residual voltage at 20 kA	kVp	925	---	---	----
27	Current for pressure relief test	kArms	63kArms at Raigarh 50 kArms at Pogalur	40	40	25
28	High current short duration test value (4/10 microseconds)	kAp	100			
29	Low current long duration test value (2400 microseconds)		As per IEC			
30	Insulator		polymer	polymer	polymer	polymer

The equipment must conform to the latest revision of all relevant IEC standards.

1.4 Type tests

The bidder shall offer type tested equipment for the project and the Employer shall accept the equipment type test reports under the following conditions:

- (i) Type test in accordance with the IEC 60099-4
- (ii) Type tests performed within seven (7) years for 336kV arresters and ten (10) years for other arresters from the **date 28-07-2015**
- (iii) The type tested equipment shall be of the same design, insulation class and rating as per the equipment offered under this contract

In the event that equipment furnished includes important modifications of, or significant departure from, the designs of equipment on which type test report has been furnished or if there is evidence that the equipment does not comply with the requirements of the Specifications, type test procedure was not properly followed as laid down in standards, the bidder shall conduct the type tests without any cost implication to the Purchaser.

1.5 Qualifying requirements (applicable for 400kV & 132kV)

- 1) The manufacturer whose Surge Arresters are offered should have manufactured and type tested as per IEC/IS or equivalent standard and supplied the Surge Arrester for the specified energy capability with rated system voltage and which are in operation for at least 2 (two) years as on the originally scheduled **date 19-05-2017**.
(or)
- 1) Surge Arresters can also be offered from Surge Arrester manufacturer(s) who have established production line in India based on technological support of a parent company or collaborator for the Surge Arresters provided that
 - a) Such manufacturer(s) have manufactured and type tested the Surge Arrester (as per IEC/IS or equivalent standard) to the specified energy capability with rated system voltage.
 - b) the parent company (Principal) or collaborator meets qualifying requirements stipulated under 1.5 1) given above
 - c) Furnishes (jointly with parent company or collaborator) a legally enforceable undertaking to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s)

1.6 Deviations

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

2 Equipment Specification

2.1 General

This section covers the general technical requirements of metal oxide arresters. In case of any discrepancies between the requirements mentioned in this section and those specified in section-3 of this specification, this section shall prevail and shall be treated as binding requirement.

The arresters are installed to protect vital equipments against the detrimental impact from overvoltages produced by lightning, switching, internal or external station faults and other system disturbances.

2.2 Standards

The metal oxide arresters and accessories shall conform to the following standards.

IEC 60099-4	Lightning arresters - Part 4: Metal oxide surge arresters without gaps for AC systems
IEC – 60270	Partial Discharge Measurements
IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000V
IEC 61462	Composite hollow insulators

2.3 Technical data

2.3.1 Electrical data

Electrical data and testing parameters shall be in line with section 1 of this document. The supplier / bidder shall submit GTP, drawings and valid type tests reports at tender and contract stage.

2.4 Design

2.4.1 Arrester design

The features and constructional details of arresters shall be in accordance with requirement stipulated hereunder.

- a) Arresters shall be of hermetically sealed units, self supporting construction and generally suitable for mounting on tubular support structures.
- b) The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.
- c) The arresters shall be designed to withstand a certain degree of contamination. Site pollution shall be considered as Heavy as per IEC 60815 (1986).
- d) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.
- e) The outer insulator shall be of composite housing. The outer insulator housing shall be so coordinated that external flashover will not occur due to

application of any impulse or switching surge voltage upto the maximum design value for the arrester.

- f) The end fittings shall be made of non-magnetic and corrosion proof material.
- g) Internal components shall be designed to minimize internal corona and also to ensure minimal capacitive coupling with any conducting layer of pollutant on the outside of the polymer housing. Organic materials are not permitted as this may influence the reliability of the arrester.
- h) The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer formed across each block shall be furnished by the Bidder. Metalizing coating thickness for reduced resistance between adjacent discs shall be furnished along with procedure for checking the same. Details of thermal stability test for uniform distribution of current on individual disc shall also be furnished.
- i) The sealing arrangement of the surge arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.
- j) The cantilever strength of the surge arrester with polymer housing shall not be less than 150 kg.
- k) The surge arresters shall 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. Details shall be furnished in the bids along with quality checks.

Pressure relief class shall be as per Table VII of IS-3070 or equivalent.

2.4.2 Duty requirements

- 1) 420 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energization with a sequential voltage profile as specified below:
 - 650 kVp for 3 peaks
 - 575 kVp for 0.1 sec
 - 550 kVp for 1sec
 - 475 kVp for 10 sec
- 2) 145 kV class arrester shall be capable for discharging energy equivalent to class 3 of IEC for 145 kV system on two successive operations
- 3) The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

2.4.3 Seismic Requirements

The arrester shall conform to the seismic requirements as specified in section-3 of this document.

2.5 Accessories

2.5.1 Surge Counters and Leakage Current Meters

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/ phase unit along with necessary connection. Suitable leakage current meters for the arresters with no key interlocking system during operation should also be supplied within the same enclosure. The reading of the ammeter 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 minimum possible bends. The surge counter shall be provided with a potential free contact rated for 220 Volt (DC) which shall close whenever a surge is recorded by the surge monitor; potential free contacts provision is required for 336kV arresters only. Necessary arrangement shall be provided for extending the contact information to Substation Automation System/RTU.

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 mounting pad.

Discharge counters shall be mounted on support structure of the arrester and surge counters and leakage current meter shall be located in such a way that the readings can be taken during energised condition of the equipment. Connection between the Surge Arrester base and Surge Monitor shall be through a 4.0 m (minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area. The copper rod/strip 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. Total length (instead of pieces) of the insulated copper rod/strip for all arresters shall be supplied to each site separately.

2.5.2 Terminals

The HV terminals shall be suitable for the type of connection specified in below table. The earth terminal shall be designed for the connection of a copper rod/strip as specified in 2.5.1 above.

Sl.No	Arrester	HV Connector
1	336 kV Arresters	Horizontal/Vertical takeoff, suitable for twin/quad ACSR conductor <i>(or) suitable for horizontal through for Al. tube</i>
2	120 kV Arrester	Horizontal/Vertical takeoff, suitable for single ACSR conductor <i>(or) suitable for horizontal through for Al. tube</i>
3	96 kV Arrester	Horizontal/Vertical takeoff, suitable for twin/quad ACSR conductor <i>(or) suitable for horizontal through for Al. tube</i>

4	30 V Arrester	Horizontal/Vertical takeoff, suitable for single ACSR conductor <i>(or) suitable for horizontal through for Al. tube</i>
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Grading/Corona rings shall be provided on each complete arrester unit, if required to meet the corona / RIV specification. The maximum terminal force shall be stated in the arrester outline drawing.

2.5.3 Base

Each installed arrester shall be equipped with an insulating base having provision for bolting to flat surface of structure.

2.5.4 Fixing hardware

Hot dip galvanized (M10 and above) or electro-galvanized (below M10) hardware shall be provided for the following, as applicable.

- Bolting of individual arrester units and unit to insulating base.
- Bolting of insulating base to steel structure / concrete pedestal.
- Bolting the surge monitor and leakage current meter to structure/concrete pedestal.
- Bolting the HV and LV terminals to the arrester.
- Bolting the interconnecting copper lead from arrester earth terminal to surge monitor.
- Bolting of corona ring to arrester unit.

Where ever required, plain washers with spring washers, plain and lock nuts shall be provided. 10% extra hardware shall be supplied marked as spare.

2.5.5 Name plates

The material of nameplate shall be stainless steel. The information on the Nameplates shall be in accordance with IEC 60099-4, clause 4.1.

2.6 Tests

2.6.1 Type Tests

Certified test reports of previously performed type test on similar units may be submitted for approval, unless specified otherwise in section-1 of this document. Old test reports shall be submitted together with a technical report from the supplier, giving details regarding similarities and differences in the design to support the approval. Such type test reports, if approved, are accepted in lieu of performing new type tests. These type test reports should not be older than **seven (7) years for 336kV arresters and ten (10) years for other remaining arresters** from the date of 28th July 2015. The type tests shall be carried out free of charge and without delivery implications, in case the test report is found unsatisfactory. The general testing procedure in all tests shall be in accordance with IEC 60099-4.

2.6.1.1 Additional type tests

Additional type tests are required for above 72.5 kV class surge arresters only, shall also be submitted for the employer review.

- (1) Radio interference voltage test as per IEC 60099-4
- (2) Seismic withstand test as per Annexure-B of section 3
- (3) Accelerated aging test
- (4) Test to verify the Power frequency versus time characteristics. Temporary over voltage profile for 216 kV and below rated arresters to be mutually agreed.

Each metal oxide block of surge arresters shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC: 60099-4.

2.6.2 Routine Tests

2.6.2.1 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. P.D. Measurement, reference voltage, residual voltage & IR measurement)

2.6.2.2 Measurement of reference voltage

2.6.2.3 Residual voltage test of arrester unit

2.6.2.4 Internal ionisation test (Or) partial discharge test

2.6.2.5 Verticality check on completely assembled surge arrester as a sample test on each lot

2.6.2.6 Test on surge monitors

The surge counters shall be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficiency of the same. Additional routine/functional tests with one 100 A (switching surge) and 10 kA current impulse (8/20 microsec) shall be performed on the surge counter.

Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapors shall be visible on the monitor glass.

2.6.2.7 Test on insulators

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.

2.6.3 Acceptance tests

The acceptance tests shall be carried out by the supplier on arresters of each type and rating as per IEC 60099-4, clause 9.2.

1.	Reference Voltage Measurement	9.2.1a)
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2.	Lightning Impulse Residual Voltage Test	9.2.1b)
3.	Partial Discharge Test	9.2.1c)

2.6.3.1 Special acceptance test

1. Thermal stability test on three sections
2. Aging test for Zinc oxide blocks as an acceptance test 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 norm being I_r (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.
3. Wattloss test



3 General Technical Requirements

Please refer TB-391-316-000: 'General Technical Requirements- Section 3'

Generally applicable clauses are 3.1 to 3.11; 3.13, 3.14, 3.16.2, 3.16.4, 3.17, 3.18, 3.22, 3.25.