



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

COPYRIGHT & CONFIDENTIAL. The Information in this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. This must not be used directly or indirectly in any way detrimental to the interest of the company.

BHEL Document No. TB 356 316 004		Rev. 00	Name	Prepared by AK	Checked by AK	Approved by DKM
Type of Document Technical Specification		Sign				
Title 390 kV & 216kV SURGE ARRESTERS		Date	22.07.17	24/07/17		
		Group	TBEM			
		W.O. No				
CUSTOMER PHPA - I/ PHPA - II, Bhutan						
CONSULTANT		WAPCOS Ltd, Gurgaon Central Electricity Authority, New Delhi				
PROJECT		1. 6X200 MW PUNATSANGCHHU-I HEP, BHUTAN 2. 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN				
CONTENTS						
SECTION	TITLE	PAGE				
1	Scope, Specific Technical Requirement & Quantities ANNEXURE-1: Customer Specification	1-1 to 1-3 1-1 to 1-8				
2	Equipment Specification	2-1 to 2-5				
3	Project details & General Specification	3-1 to 3-21				
4	Guaranteed Technical Particulars	4-1 to 4-6				
5	Check List	5-1 to 5-2				
REVISION DETAILS						
Rev No.	Date	Altered	Checked	Approved		
Distribution				To		
				Copies		



SECTION I

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 390kV & 216kV Surge Arrestors **Punatsangchhu-I & Punatsangchhu-II** projects complete with all accessories like surge counter, insulating base, connecting lead and fixing hardware etc.

In case of any conflict between the technical details mentioned in this section and the remaining sections of this document, then Section-1 shall prevail and is to be considered as binding requirement.

1.1 390kV & 216kV class surge arrestors are required for the following projects,

Project Title	:	6x200MW Punatsangchhu – I Hydroelectric Project, Bhutan	6x170MW Punatsangchhu – II Hydroelectric Project, Bhutan
Customer	:	Punatsangchhu – I Hydroelectric Project Authority (PHPA-I), Bhutan	Punatsangchhu – II Hydroelectric Project Authority (PHPA-II), Bhutan
Consultant	:	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi

Refer Section-3 for Project Details and General Specifications.

2.0 SPECIFIC TECHNICAL REQUIREMENTS

Refer Annexure-1 for customer specification.

2.1 Technical parameters

S. No.	Technical parameter	Unit	390 kV Surge arrester	216 kV Surge arrester
1	Type	-	Heavy Duty, Metal Oxide, Gapless type	
2	Applicable standards	-	IEC 60099-4	
3	Installation	-	Hermetically sealed outdoor type	
4	Mounting	-	Tubular/ Lattice Structure	
5	Design Ambient Temperature	deg. C	35	40
6	Nominal System Voltage	kV	400	220
7	Highest System Voltage	kV	420	245
8	Rated Arrester Voltage	kVrms	390	216
9	Rated Frequency	Hz	50	50
10	Maximum Continuous Operating Voltage at design ambient temp.	kVrms	303	168



S. No.	Technical parameter	Unit	390 kV Surge arrester	216 kV Surge arrester
11	Maximum Switching level at 1kA	kVp	780	---
12	Maximum Discharge voltage level at 10kA	kVp	1050	795
13	Long Duration Discharge Class		3 as per IS: 3070 (part-1)	
14	Rated Nominal Discharge Current (8/20 μ sec.)	kAp	10	10
15	Pressure Relief Class	kA	A - 50 kA	A - 40 kA
16	Minimum Energy Discharge Capability	kJ/kV	10	
17	Minimum Creepage requirement	mm	10500	6125
18	Rated insulation levels for arrester housing			
18.1	Lightning impulse level	kVp	1425	1050
18.2	Switching surge impulse level	kVp	1050	-
19	One minute power frequency withstand voltage (dry & wet)	kVrms	630	460
20	Maximum radio interference voltage for frequency between 0.5 MHz and 2 MHz	micro volts	1000 (at 266 kV rms)	500 (at 156 kV rms)
21	Corona Extinction voltage	kVrms	320	156
22	Prospective symmetrical fault current	kArms	50	40
23	Partial discharge at 1.1 Un/v3	pC	≤ 10	
24	Maximum residual voltage at			
24.1	5 kA nominal discharge current	kVp	865	560
24.2	10 kA nominal discharge current	kVp	900	510
24.3	20 kA nominal discharge current	kVp	975	As per IEC
25	High current short duration test value (4/10 microseconds)	kAp	100	
26	Low current long duration test value (2400 microseconds)		As per IEC	
27	Insulator		Porcelain	
28	Minimum Cantilever Strength of complete arrester	Kg	500	
29	Availability of "NO" potential free contact which should be closed in case of surge		YES	YES

4.0 BILL OF QUANTITIES

a) Quantity for PHPA-I:

S.No.	DESCRIPTION	QUANTITY	
		Main	Spare
1.	390kV Surge arrestor (single phase) complete with all accessories like corona ring, terminal pad and terminal connector suitable for twin moose conductor, surge counter, insulating base, connecting cable, fixing hardware etc.	12 Nos.	4 Nos.



2.	216kV Surge arrestor (single phase) complete with all accessories like corona ring, terminal pad and terminal connector suitable for single moose conductor, surge counter, insulating base, connecting cable, fixing hardware etc.	6 Nos.	2 Nos.
----	---	--------	--------

b) **Quantity for PHPA-II:**

S.No.	DESCRIPTION	QUANTITY	
		Main	Spare
1.	390kV Surge arrestor (single phase) complete with all accessories like corona ring, terminal pad and terminal connector suitable for twin moose conductor, surge counter, insulating base, connecting cable, fixing hardware etc.	18 Nos.	5 Nos.

c) **ACCESSORIES REQUIRED (Separately for PHPA-I & PHPA-II)**

1. Insulating base : Yes
2. Surge Monitor : Yes, Counter of IP-55 class, 6 digit cyclometer at (Millimeter +surge counter) least 5 counts/sec.
3. HV Power connector : Yes
4. Corona grading ring : Yes
5. Insulated interconnecting cable between : Yes, in single length for all SA.
arrestor and surge monitor. **(5m long for each SA)**
Surge counter **Cu lead** shall be supplied in one length for all LAs and suitable lugs shall be supplied as loose items.
6. Hardware for bolting the arrester units : Yes
(Inter-unit fixing)
7. Hardware for Fixing the surge arrester & : Yes
surge monitor to structure
8. Type tests required to be carried out : No, if relevant valid type test certificates are
on the arrester in the scope of supply available

5.0 **TYPE TESTS:**

The offered equipment should have been successfully type tested as per relevant IS/IEC and valid test reports of following type tests shall be submitted.

Bidder shall submit valid reports of type tests for isolators carried out within **ten years from 09.02.12 for Punatsangchhu-1 & 08.04.2013 for Punatsangchhu-2**. If these tests have been conducted more than 10 years prior from the mentioned dates or the test reports are not valid to the satisfaction of purchaser, the type tests shall be conducted/ re-conducted by bidder with no extra cost to BHEL/PHPA.

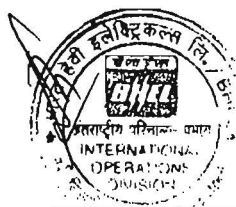
7.4.4 SURGE ARRESTORS

7.4.4.1 Type & Rating

7.4.4.1.1 Each gapless Surge Arrestor shall conform to IEC-99-4 and shall be of hermetically sealed unit, self supporting construction suitable for mounting on tubular / lattice support structure. The Surge Arrestors will be connected to the overhead 420 kV lines having Twin-Moose & 220 kV lines having single Moose ACSR conductors, as such, the terminal connectors of the suitable sizes shall be provided.

7.4.4.1.2 The Surge Arrestors shall have following parameters and ratings:

Particulars	400kV System	220kV System
- Rated voltage of arrestor (kV _{rms})	390	216
- Type of arrestor	Heavy duty, metal oxide, gapless type	
- Maximum discharge current (kA)	10	
- Max. switching surge level at 1kA, (kV _p)	780	-
- Maximum discharge volt at 10kA (kV _p)	1050	795
- Max. wave protective level at 10 kA (kV _p)	900	710
- Lightning Impulse withstand voltage for LA housing (kV _p)	1425	1050



Switching surge withstand voltage for housing (kV _p)	1050	-
- 1 minute power frequency withstand voltage for housing (kV _{rms})	630	460
- Radio interference voltage at 266/156 kV _{rms}	< 1000 μ V	< 500 μ V
- Partial discharge level at 1.1 Un / $\sqrt{3}$	< 10 pC	
- Corona extinction voltage (kV _{rms})	320	156
- Energy level (kJ/kV)	10	
- Long duration discharge class	3 as per IS: 3070 (Part I)	
- Minimum creepage distance (mm)	10500	6125
- Prospective symmetrical fault current kA _{rms}	50	40
- Pressure relief class	As per IS: 3070 (Part I)	

7.4.4.1.3 The Arresters shall have following duty requirements:

- i) The Surge Arresters shall be capable of discharging over-voltages occurring during switching of unloaded Transformers and long lines.
- ii) The Arresters shall be capable of discharging energy equivalent to class 3 for both 420kV & 220kV systems on two successive operations followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:
 - 705 kV_{peak} for 3 peaks
 - 580 kV_{peak} for 0.1 sec
 - 565 kV_{peak} for 1.0 sec
 - 550 kV_{peak} for 10 secs

7.4.4.2 Technical Requirements

7.4.4.2.1 The Surge Arresters shall be fitted with pressure relief devices suitable for providing path for flow of rated fault currents in the event of Arrester failure.

7.4.4.2.2 The Arresters shall not fail due to porcelain housing contamination. Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

7.4.4.2.3 Porcelain 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 Arrester.

7.4.4.2.4 The end fittings shall be made of corrosion proof material and shall preferably be nonmagnetic.

7.4.4.2.5 The name plate shall conform to the requirements of IEC incorporating the year of manufacture and other details.

7.4.4.2.6 Self contained discharge counters, suitably enclosed for outdoor use shall be provided for each single pole unit alongwith necessary connections. Suitable leakage current metres should also be provided within the same enclosure. The reading of ammeter and counters shall be visible through an inspection glass panel. The design of the surge monitor shall be such that it is possible to tilt



the surge monitor down wards by an angle of upto 45° from Horizontal plane.

7.4.4.2.7 Surge monitor consisting of discharge counters and ammeters should be suitable to be mounted on support structure of the Arrester and should be tested for IP:55 class of protection. The arresters shall be complete with insulating base having provision for bolting to the structure. The standard supporting structure for Surge Arrester shall be provided with a standard mounting pad for fixing the surge monitor. Grading/corona rings shall be provided on each complete Arrester unit as required.

7.4.4.2.8 **NA**

7.4.4.2.9 **NA**



7.9 INSPECTION & TESTS

7.9.1 General



All the equipment, apparatus, materials and supplies covered under these specifications shall be subjected to tests in the shop and at the field in the presence of the representatives of the Purchaser/consultants for conformity with the requirements of the

specifications. The method and procedure for the tests shall be as specified for particular item or shall be in conformity with the applicable standards for making such tests. The details of the test procedures and test equipment to be used should be intimated well in advance i.e. less than 30 days before these tests are conducted.

- 7.9.1.2 The purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of purchaser shall have at all reasonable times access to the supplier's premises or works and shall have the power to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works being manufactured or assembled at sub-supplier's premises or works, the supplier shall obtain permission for the purchaser and for his duly authorised representative to inspect at the sub-supplier's premises or works. The equipment, if found unsatisfactory at any stage as to workmanship or material is liable to be rejected.
- 7.9.1.3 The test reports shall indicate the tests performed, the results obtained, instruments used, names of personnel carrying out the tests and provision for signature of the witnesses. They shall also show the test report number and the date of conducting the test. The format of these reports shall be submitted alongwith testing procedures for the Purchaser's approval well in advance.
- 7.9.1.4 All services such as labour, materials, electricity, fuel, water, stores, apparatus and instruments required for conducting any or all tests shall be arranged & provided by the supplier at his cost.

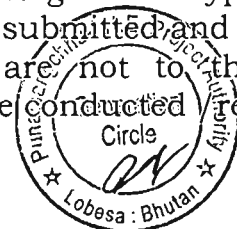
7.9.2 Inspection & Testing of Pothead Yard Equipment

The Pothead Yard equipment shall be subjected to the type and routine tests in accordance with the relevant ISS / IECs as indicated here under -

- a) **NA**
- b) **NA**
- c) **NA**
- d) Each Surge Arrestor shall be subjected to type & routine tests as per IEC 99-4

7.9.3 Type Tests

- 7.9.3.1 The type test reports of the following type tests conducted on similar rating equipment of the make proposed to be supplied by the supplier, shall be submitted during the design stage. If the type test reports of any or all the following tests are not submitted and if the type test reports of the tests conducted are not to the satisfaction of the Purchaser, the type tests shall be conducted by the Supplier at his own expenses.



7.9.3.5 Surge Arrestors (As per IEC 99)

- a) High voltage withstand tests
- b) Residual voltage tests
- c) Long duration current impulse withstand test
- d) Operating duty tests
- e) Pressure relief test
- f) Test of Arrestor disconnectors
- g) Artificial Pollution test
- h) Seal leakage test
- i) Current distribution test for multi- column arrestor

7.9.4 Routine tests

The following routine tests shall be carried out by the manufacturer at his works in the presence of purchaser.

7.9.4.1 Current Transformers (As per IEC-185 / IS-2705)

- a) Verification of terminal markings and polarity test
- b) Power – frequency dry withstand test on primary windings
- c) Power-frequency dry withstand tests on secondary winding
- d) Partial discharge measurement (As per IS 11322)
- e) Over voltage inter-turn insulation test.



7.9.4.4 Surge Arrestors (As per IEC-99)

- a) Measurement of reference voltage.
- b) Residual voltage test.
- c) Partial discharge measurement test
- d) Content noises to be checked on each unit
- e) Pressure leakage check on sealed housing of each unit
- f) Current distribution test for multi-column arrester.

- d) Drawing showing details of mounting of CTs on support structures.
- e) Detailed drawing of support structures and it's foundation
- f) Drawing depicting power frequency and impulse flash over voltage for various gap distances of arcing horns
- g) Technical & descriptive literature explaining the details of equipment.

7.10.1.2 Capacitive Voltage Transformers:

- a) Outline dimensional drawings showing net weights and shipping dimensions
- b) Assembly drawings
- c) Typical details of terminal connectors
- d) Typical insulator drawings
- e) Detailed drawings of mounting of CVTs and support structures
- f) Detailed drawings of foundation
- g) Technical and descriptive literature giving the details of the CVTs

7.10.1.3 Isolators with Earthing Switches:

- a) Outline dimensional drawings showing clearances, net weights and shipping dimensions
- b) Assembly drawings
- c) Typical drawings of the operating mechanism, cubicles, auxiliary devices and interlocking devices
- d) Typical drawing showing the arrangement of contacts
- e) Drawing showing the details of terminal connectors
- f) Typical outline drawings for Insulators
- g) Details of typical support structures, Isolators, Earthing Switches etc
- h) Detailed foundation drawing
- i) Technical and descriptive literature giving the details of isolators

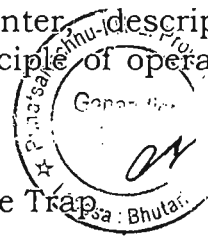
7.10.1.4 Surge Arrestors (Drawings, documents to be submitted)

- a) Outline dimensional drawings, net weights and shipping dimensions.
- b) Assembly drawing.
- c) Drawing showing details of pressure relief device.
- d) Drawing showing clearance from grounded objects and between adjacent poles of lightening arresters required at various heights of surge arresters.
- e) Drawing showing mounting details.
- f) Drawing showing details of terminal connectors.
- g) ~~Drawing for supporting structures alongwith the mounting details.~~
- h) Drawing showing details of surge counter, descriptive literature explaining action of LA and principle of operation of the surge counter.



7.10.1.5 Wave Traps

- a) Outline and mounting arrangement for Wave Trap





SECTION - 2 EQUIPMENT SPECIFICATION

2.1 GENERAL

This section covers the general technical requirements of the surge arresters. The surge arrestor shall confirm to IEC: 60099-4 except to the extent modified in this specification and shall also be in accordance with requirements under section-3, Project details and General Technical requirements.

2.2 APPLICABLE STANDARDS

The lightning Arresters shall mainly be designed as per IEC-99-4 document and wherever necessary compliance may be made to the latest edition of the following IS/IEC unless otherwise stated in this specification:

DESCRIPTION	STANDARD NO.
Gapsless LA	: IEC: 60099-4
Lightning Arresters for alternating current systems	: IS : 3070
Requirements for measuring equipments	: IEC-60060-3
Partial discharge measurement	IEC-600270
Artificial Pollution Testing of LA	IEC-60099-3
Methods of II.V. testing	IS-2071
IEE standards for surge arresters for AC power circuits	: ANSI-C62.1
Surge Arresters	: NEMA-LA 1
Method for testing uniformity of coating of Zinc coated articles.	: IS: 2633-1986
Recommended practice for hot-dip galvanising on iron & steel	: IS: 2629 - 1985
Hot dip Zinc coating on structural steel and other allied products.	: IS: 4759 - 1984
Electric power connectors	: IS: 5561-1970
Hollow insulator for use in electrical equipment	: IS: 5621- 1980
Method for determination of mass of zinc coating on iron and steel articles.	: IS: 6745- 1972

2.3 TECHNICAL REQUIREMENT OF EQUIPMENT

Surge arrestor shall be hermetically sealed units, self supporting construction suitable for mounting on tubular/Lattice support structures to be supplied by BHEL.

The surge arrestor shall be designed for use in the **geographic and meteorological conditions as given in Section-3** Project details.

The surge arrestor shall conform in general to IEC-99-4 document or its latest amendment.



2.4 DUTY REQUIREMENT

- (a) The surge arresters shall be of heavy duty station class and gapless type without any series or shunt gaps. Live parts shall comprise of non-linear metal oxide resistor without spark gap.
- (b) The Arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.
- (c) 420 kV class Surge arresters shall be capable of discharging of severe re-energisation switching surges on a 400 kV, 450 km long line with Surge impedance of 300 ohms and capacitance of 11.986nF/km and over voltage factor of 2.3 p.u.
- (d) 420 kV class arrester shall be capable of discharging energy equivalent to **class 3** of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:
 - 705 kVp** for 3 peaks
 - 580 kVp** for 0.1 Sec
 - 565 kVp** for 1 seconds
 - 550 kVp** for 10 seconds
- (e) The surge arrestor shall be suitable for withstanding forces as defined in Section-3 of this specification.
- (f) The reference current of the arrestors shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

2.5 CONSTRUCTIONAL FEATURES:

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

- a) 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.
- b) 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 alongwith quality checks.
- c) The arresters shall not fail due to arrester insulation contamination.
- d) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.
- e) Outer insulator FOR 400kV class Surge Arrestor shall be porcelain. Terminal connectors shall conform to requirements stipulated in section-3 & other relevant IS/ IEC.

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.

- f) The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.
- g) The name plate shall conform to the requirements of IEC incorporating the year of manufacture.
- h) The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer formed across each block are to be furnished. Metalizing coating thickness for reduced resistance between adjacent discs is to be furnished with additional information schedule of bid proposal sheets alongwith procedure for checking the same. Details of thermal stability test for uniform distribution of current on individual disc is to be furnished.
- i) The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.
- j) 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.
- k) **The Cantilever strength of the complete surge arrester (i.e. combined strength in case of multi units) with porcelain housing shall not be less than 500kg.**

2.6 FITTINGS AND ACCESSORIES:

- a) Arresters shall be complete with insulating base having provision for bolting to flat surface of structure.
- b) 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 alongwith necessary connection. 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 minimum possible bends. The surge counter shall be provided with a potential free contact rated for 220VDC, which shall close whenever a surge is recorded by the surge monitor.
- c) 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 IP55 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. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to 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 a 5.0 m(minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area. 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.

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

2.7 TESTS:

In accordance with the requirements stipulated under Section-1 & 3, the surge arresters should have been type tested as per IEC/IS and shall be subjected to routine and acceptance tests in accordance with IEC document.

The test reports of the type tests & the following additional type tests shall also be submitted for purchasers review,

- i. Radio interference voltage test as per IEC 60099-4.
- ii. Accelerated aging test
- iii. Test to verify the power frequency vs time characteristics. Temporary over voltage profile for 216kV & below 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.

2.7.2 (a) Acceptance tests:

1. Measurement of power frequency reference voltage of the arrester units.
2. Lightning impulse residual voltage on arrester units (IEC clause no. 6.3.2)
3. Internal Ionisation or partial discharge test.

(b) Special acceptance test:

1. Thermal stability test on three sections (IEC clause no. 7.2.2)
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 1150C. Acceptance norm being Ir (resistive current)/watt loss shall remain or decrease at the end of 72 hour from the value taken after 1 hour of start of test.
3. Wattloss test.

(c) Routine tests:

1. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor 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. Measurement of reference voltage.
3. Residual voltage test of arrester unit
4. Internal Ionisation test or partial discharge test.
5. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) Test on surge monitors:

The Surge monitors shall also 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. 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.

(e) Test on insulators

All routine tests shall be conducted on the hollow column insulators as per IEC-233. The following additional tests shall be carried out on 420 kV insulators:

- i) Ultrasonic test as a routine test.
- ii) Pressure test as a routine test.
- iii) Bending load test in 4 directions at 50% specified bending load as a routine test.
- iv) Bending load test in 4 directions at 100% specified bending load as a sample test on each lot
- v) Burst pressure test as a sample test on each lot.

2.8.1 Following drawings shall be submitted at the contract stage

- 1. General Arrangement drawing of surge Arrester
- 2. General Technical Particulars
- 3. Drawing of Porcelain Insulator
- 4. Cross Sectional View
- 5. Arrester and unit name plate
- 6. Grading ring
- 7. Insulating Base/Surge Counter detail
- 8. OGA of Surge Counter
- 9. Circuit diagram of Surge Counter
- 10. GA of ZnO element
- 11. Line Terminal bracket With Corona Ring
- 12. Drawing Showing Pressure Relief Arrangement
- 13. Type Test Reports
- 14. Instruction Manual



SECTION - 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

GENERAL TECHNICAL REQUIREMENTS

1.0 PROJECT LOCATIONS

6X200 MW PUNATSANGCHHU-I HEP :- The Project is located on Punatsangchhu River in Wangdue Phodrang Dzongkhag in Western Bhutan. Access to the project site is from right bank through Wangdue-Tsirang highway. All the project components are located on the left bank of river Punatsangchhu, between 6.5 km and 16 km downstream of Wangdue Bridge. The dam site is about 80 km from Thimphu and is connected by highway.

Paro (Bhutan) is the nearest airport (about 110 km). The nearest railway station is Hasimara (India) on Siliguri - Alipurduar Broad Gauge line of NF Railway. The project area could be approached from Bagdogra airport near Siliguri via Phuentsholing - Semtokha (near Thimphu) - Dochula (about 425 km). The project area can also be approached from Gelephu.

6X170 MW PUNATSANGCHHU-II HEP :- The Project is located on Punatsangchhu River in Wangdue Phodrang Dzongkhag in Western Bhutan. Access to the project site is from right bank through Wangdue-Tsirang highway. All the project components (except diversion tunnel) are located on the right bank of river Punatsangchhu, between 22 km and 38 km downstream of Wangdue Bridge. The dam site is about 94 km from Thimphu and is connected by highway.

Paro (Bhutan) is the nearest airport (about 125 km). The nearest railway station is Hasimara (India) on Siliguri - Alipurduar Broad Gauge line of NF Railway. The project area could be approached from Bagdogra airport near Siliguri via Phuentsholing - Semtokha (near Thimphu) - Dochula (about 440 km). The project area can also be approached from Gelephu.

2.0 PROJECT DETAILS

Project Title	:	6x200MW Punatsangchhu – I Hydroelectric Project, Bhutan	6x170MW Punatsangchhu – II Hydroelectric Project, Bhutan
Customer	:	M/s Punatsangchhu – I Hydroelectric Project Authority (PHPA-I), Bhutan	M/s Punatsangchhu – II Hydroelectric Project Authority (PHPA-I), Bhutan
Consultant	:	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi
Postal Address	:	Superintending Engineer	Superintending Engineer



Project: 6X200 MW PUNATSANGCHHU-I HEP & 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN
Customer: PHPA-I & II BHUTAN

Technical Specification

Doc No: TB-356-316-0XX

Section-3: Project Details & General Specifications

Rev. No. 00

	(Generation) Punatsangchhu-I Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)- 02-376135	(Generation) Punatsangchhu-II Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)-02-376135
--	--	--

2.1 SITE CONDITIONS (FOR DESIGN PURPOSES)

2.1.1 SITE CONDITIONS

		<u>PHPA-1</u>	<u>PHPA-2</u>
a).	Average rainfall per year	: 665.11 mm	665.11 mm
b).	No. Of months of tropical monsoon	: 5 (May to Sept)	5 (May to Sept)
c).	Altitude (Pothead Yard over ground)	: EL 887	EL 648

2.1.2 DESIGN AMBIENT

		<u>PHPA-1</u>	<u>PHPA-2</u>
a).	Minimum Temperature	: 4.0°C	4.0°C
b).	Maximum Temperature	: 35°C	40°C
c).	Design Ambient Temperature	: 35 °C	40 °C

2.1.3 RELATIVE HUMIDITY

a). Maximum :: 100%

2.1.4 WIND PRESSURE (AS PER IS:875-1987)

a). Design wind speed : 47 m/sec.

2.1.5 SEISMIC FACTORS

The Power House site is located in seismic zone-IV, as such, various equipment shall be designed for installation and operation in earthquake prone area. The seismic loads occur due to the horizontal and vertical accelerations which may be assumed to act non-concurrently. **The coefficients for horizontal acceleration as 0.4g and vertical acceleration as 0.2g shall be used for design purposes.** The seismic loads shall be equal to the static loads corresponding to the weights of the parts / accessories multiplied by the coefficient of the acceleration.



The base frame / supports and fixing devices of various equipment shall be strong enough to withstand the forces in normal operation and in abnormal conditions with forces superimposed due to occurrence of earthquake and short circuit simultaneously. The civil foundation drawings and the embedment which are to be grouted in concrete shall be supplied by the bidder. The copies of type test reports for similar type of foundation equipments, if tested earlier, should be furnished alongwith the bid. If the equipment covered in this package have not been type tested earlier, design calculations of simulated parameters should be furnished during design stage.

To prevent the movement of various equipment and its parts during earthquake, suitable devices shall be provided for fixing of various equipment with the foundations. The bidder shall include necessary bolts and fittings for embedding in the concrete foundation in their scope of supply.

2.1.6 COMMUNICATION & TRANSPORT LIMITATIONS

The transport limitation by road from Phuentsholing to the project site would be the governing factor in respect of the permissible package size and weight.

The existing roads, wherever required, will be improved and upgraded to allow the transport of the packages of the following size and weight. However, the bidder shall make his assessment regarding road condition while dispatching such packages.

i) Size in meters (LXBXH) = 14mx5mx4m (without height of the trailer)

ii) Weight (tonnes) = 100 tonnes (including weight of trailer with multiple wheels preferably hydraulic maneuvering wheels).

The bidders shall design their equipment such that the transport packages are within the above limitations.

Lighter packages with reduced width and height but with lengths up to 18 m can be transported, which shall, however, be subject to prior confirmation from the purchaser.

2.1.7 AUXILIARY POWER SUPPLY

		415V AC System	220V AC System	220 V DC System (Un grounded)
1.	Nominal Voltage	415 V	220 V	220 V
2.	No. of phases	3ph, 4 wire	1ph, 2 wire	2 wire
3.	Frequency (Hz)	50 $\pm$ 3 %	50 $\pm$ 3 %	NA
4.	Voltage variation	$\pm$ 10 %	$\pm$ 10 %	$\pm$ 10 %



2.1.8 SYSTEM PARAMETERS

S. No.	Description	400 kV System	220 kV System
a)	Lightning Impulse Withstand Voltage (kVp)	1425	1050
b)	Switching Impulse Withstand Voltage (kVp)	1050	-
c)	P.F. Withstand Voltage (kVrms)	630	460
d)	Highest System Voltage (kV)	420	245
e)	Creepage Distance (mm)	10500	6125
f)	Short Circuit Capability (kA for 1sec)	50	40

2.1.9 MINIMUM CLEARANCE

S. No.	Description	400 kV System	220 kV System
a)	The minimum vertical clearance from any energized metal part to the top of the plinth	8.0 m	5.0 m
b)	The minimum vertical distance from the bottom of the lowest part of bushing or supporting insulators to the top of plinth	2.55 m	2.44 m
c)	The minimum clearance between the live parts and earth	3.4 m	2.1 m
d)	The minimum clearance between phases	4.1 m	2.1 m
e)	The minimum sectional clearance	6.5 m	As per IS

3 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification. It is recognised that the Manufacturer may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously.

4 STANDARDS

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.



The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

In case governing standard for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in the offer along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaser's / owner's approval. The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

5 MATERIALS

5.1 General Requirements for materials

All materials of the equipment / structures shall be of first class commercial quality, considering strength, ductility, durability, best engineering practice and the normal or severe operating service to which the equipment will be subjected, free from any defects and imperfections, of recent manufacture and unused and where indicated of the classifications and grades designated therein. Materials not specifically described herein but used for manufacturing of the equipment, shall be the most suitable for the purpose and shall comply with the latest specifications of Bureau of Indian Standards, or the American Society for Testing of Materials (ASTM), or approved equivalent standards. If the bidder desires for any reason to deviate from or use materials not covered by these specifications, he shall state the exact nature of the deviation or exception and shall submit for the approval of Purchaser complete specifications of the materials he proposes to use alongwith the reason of such deviation. All materials, supplies and articles not manufactured by the bidder shall be the products of recognized, reputed manufacturers and product shall have the marking of standards to which it conforms.

The materials liable to be attacked by termites or other insects shall not be used. All workmanship shall be of the highest quality to ensure smooth functioning of equipment / material offered. The design, dimensions and materials of all parts, shall be so chosen that the electro-mechanical and thermal stresses to which they may be subjected shall not render them liable to distortion or damage under the most severe conditions encountered in actual service.



5.2 Corrosion Resistant Materials

- 5.2.1 Bronze hinge pins shall be provided for all doors.
- 5.2.2 The surface of mild steel fabricated items and other metal surfaces shall be thoroughly cleaned by grit blasting and coated with corrosion resisting paint to prevent rusting. The Bolts or Nuts, which are subject to frequent removal and the bolts to be projected above the concrete with nuts subjected to removal, shall either be of stainless steel or hot dip galvanized / electro galvanized.

5.3 Magnetic & Non-magnetic materials

- 5.3.1 Conductor material of Isolated & segregated phase bus ducts and Tubular conductors shall be of high conductivity aluminum alloy confirming to relevant standard.
- 5.3.2 Fixing and supporting materials of cables, bushings, bus bar enclosures etc. must be of non-magnetic material such as aluminium or nonmagnetic metallic alloy.
- 5.3.3 All sliding surfaces subject to continuous contact with grease over extended periods without movement shall be bronze or bronze faced.
- 5.3.4 Substitutions for specified materials shall be made only with the written consent of purchaser. The Bidder shall be responsible for the suitability of materials to be used in the construction of the equipment covered in various Sections of this documents.
- 5.3.5 To the extent feasible and without adversely affecting the strength and durability, materials for field welds, if required, shall be used such that these do not require preheating or stress-relieving.

6 DESIGN STRESSES

6.1 General Criteria

- 6.1.1 Liberal factors of safety shall be used throughout the design, and especially in the design of all parts subject to alternating stresses or to shock loading or to most severe operational loadings, including those due to electrical short circuit faults. The Supplier shall furnish complete information, including computations regarding the maximum unit stresses used in the design for record and reference of purchaser during design stage.
- 6.1.2 The life of equipment supplied shall be not less than thirty five (35) years.

7 WORKMANSHIP

7.1 General Requirements

- 7.1.1 Workmanship shall be of the highest grade and in accordance with the best modern practices for the manufacture of high-grade machinery, notwithstanding any omissions from these specifications or associated drawings. All work shall be performed by workmen skilled in their respective trades.
- 7.1.2 Machining of renewable parts shall be accurate and to specify dimensions according to the drawing so that replacements made may be readily installed. The Supplier shall keep and maintain in storage for at least 10 years or more, at his own expense,



sufficient templates, gauges, patterns, or other records used in the manufacture to enable him to make repair and furnish replacement parts for future needs. Notwithstanding this, if the Manufacturer/Bidder, in future, intends to wind up his business, he shall give the information to this effect to the Purchaser, sufficiently in advance, so as to enable him to consider buying life time spares before the closure of the business.

8 STRUCTURAL MATERIALS

8.1 Bolts, Nuts, Studs and Screwed Connections

All threads shall be clean and accurately cut before assembling. Screwed parts shall be lightly lubricated or coated with jointing compound as may be applicable before connection. All screwed connections shall be made adequately and no such force shall be used which may permanently deform the material. Metric threads shall be provided.

8.2 Fastening Elements for Equipment

- (i) Fastening elements for the equipment viz. the bolts, studs, nuts, screws, washers shall be of material which is most suitable for the operating conditions and the frequency of removal for dismantling of the respective components, parts. These items shall conform to relevant national or international standards.
- (ii) The fastening elements shall be of following materials depending upon the condition of operation:
 - a) Subjected to regular Corrosion resistant steel as removal for dismantling per applicable grades for maintenance or frequent adjustment.
 - b) Subjected to less frequent High tensile steel/other dismantling suitable materials per laid down practice.
- (iii) The fasteners (nuts and bolts) for the parts subjected to pressure shall be machined on the shank, under the head and nut.
- (iv) Wherever necessary, the fastening elements shall have locking devices and anti-vibration devices. The washers shall be of the taper type.
- (v) Where there is a risk of corrosion, bolts and studs shall be finished flush with surface of the nuts.
- (v) With the exception of high strength friction grip bolts, the bolts shall be designed so that with nuts fully tightened, the stress intensity at the bottom of the thread shall not exceed one half (1/2) of the yield point of the bolt material under all conditions.
- (vii) In case, nuts and bolts are of manufacturer's own standards, which are different from the usual national or international standards, the supplier shall supply taps & dies for the threads and special spanners for the nuts & bolts.
- (vi) The supplier shall state the standards to which the fastening elements offered conform.



8.3 Galvanizing

- (i) All drilling, punching, tapping, cutting, and bending of various parts shall be completed and all burrs removed prior to galvanizing.
- (ii) Galvanizing shall be applied by the hot dipped process and shall consist of the smooth, clean zinc coating free from defects and of uniform thickness. The quantity of Zinc applied shall not be less than 610g/m² of the surface area. Original blast-furnace raw-zinc (minimum purity 98%) shall be used. Sheardizing or other alternative process shall not be used without the approval of the Purchaser and / or Consultant.
- (iii) Material / parts on which galvanizing has been damaged shall be redipped unless, in the opinion of the purchaser, the damage is local and can be repaired by applying a coat of galvanizing repair paint.

8.4 Non-metallic Coatings

- (i) Coatings in this category include sprayed or sheet linings, as applied to tanks, vessels and pipes carrying aggressive fluids and wrappings as applied to buried or immersed pipe work. The materials employed may be rubber PVC sheet, glass reinforced resin or plastic.
- (ii) Surface preparation and application of the coating shall be in strict accordance with the approved instructions of the coating supplier.
- (iii) The surface of the parts to be embedded in the concrete shall be cleaned from mill scale, dirt, oil, grease and other residues and shall be covered with a substantial coating of Portland cement wash or other proprietary coating before dispatch.

8.5 Material of Rating Plates, Name Plates and Labels

- (i) Rating and diagram plates shall give the information as required in latest edition of IEC/IS standard.
- (ii) A rating plate of non-corrodible material sheets shall be attached to each major and auxiliary item of goods / apparatus and cable end terminals. This plate shall be permanently engraved with the designed full load ratings, serial number, type, date of manufacture and other identifications deemed necessary. Where necessary, diagram shall also be supplied.
- (iii) All markers/labels shall be made of **halogen & silicon free polyamide material with inflammability class V2 as per UL 94**, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest Bluemark UV technology so as to comply the Wipe Resistance according to DIN EN 61010-1/VDE 0411-1.

8.6 Machine Work

- 8.7.1 Unless otherwise shown on the approved shop drawings, all allowances, tolerances, and gauges for metal fits shall conform to applicable ISS or to ANSI Standard B4.1 for the class as shown or otherwise required. Sufficient machining allowance shall be left while placing pads to ensure true surface of solid material. Finished contact or bearing



surfaces shall be true and exact to ensure full contact.

- 8.7.2 All machined parts shall be accurately machined and like parts shall be interchangeable. Drilled holes for bolts shall be accurately located and drilled to templates when necessary or specified. The holes for fit-up bolts or dowels shall be carefully reamed and the bolt or dowel shall enter with a light driving fit. Bolt and screw threads shall conform to applicable ISS or to ISO standard.

8.8. Surface Finish

- 8.8.1 Surfaces to be machine-finished shall be indicated on the shop drawings by symbols which conform to applicable ISS or to ANSI B46.1 or to equivalent standard. Values of roughness height are specified in microns as "average deviation from the mean surface". Values of roughness, width and waviness height are not specified but shall be consistent with the general type of finish as specified by the roughness height. Compliance with the specified surface will be compared to roughness comparison specimens.

8.9 Type of Finish and Roughness Value

- (i) Surfaces which are to be machined to dimensions where the tolerance is 0.5mm or greater shall have a maximum roughness value of 12 microns.
- (ii) Stationary mating surfaces, where reasonably accurate positioning of the members or a moderately tight joint is desired, shall have a maximum roughness value of 6 microns.
- (iii) Surfaces in sliding or rotating contact, where motion is slow and loads are light, shall have a maximum roughness value of 3 microns.
- (iv) Surfaces in sliding or rotating contact, when loads and speeds are moderate, shall have a maximum roughness value of 1.6 microns.
- (v) Surfaces in sliding or rotating contact, where loads are heavy and/or the motion is rapid, shall have a maximum roughness value of 0.8 microns.

8.10 Unfinished Surfaces

So far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground or machined to secure reasonable alignment. Unfinished surfaces shall be true to the lines & dimensions shown on the drawings and shall be chipped or ground free from projections or rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in a manner approved by purchaser.

10 PAINTING AND PROTECTIVE COATINGS

10.1 General Requirements

- (a) All surfaces shall be thoroughly cleaned of rust, mill scale, oil, grease and dirt



- prior to shipment and before painting. Paint shall only be applied to dry and clean surfaces.
- (b) Except for surfaces that will be embedded in concrete and as otherwise specified, all un-machined or unturned internal or external surfaces shall be given not less than one coat of red lead primer. Any exterior surfaces requiring welding during manufacture shall be ground smooth after welding before application of the primer coat. The primer coat shall be applied quickly after the welding and grinding is over.
 - (c) Except as otherwise provided the Bidder's standard painting system for miscellaneous auxiliary equipment such as motors, motor starters, gauges, pumps, etc. will be satisfactory. All equipment shall have a neat & attractive appearance.
 - (d) Flaws in exterior surfaces shall be ground smooth before applying the prime coat. This shall in no way reduce the unit strength.
 - (e) The minimum total dry film thickness shall be **1.5 mils (38 microns)** for prime finishes 2 mils (50 microns) for lacquer finishes and 3 mils (75 microns) for enamel finishes.
 - (f) All needs of final touch up paint for application at site shall be included in the scope of supply.

10.2 Specific Requirements

Except as otherwise specified, the interior and exterior steel surfaces of cabinets/cubicles shall be thoroughly cleaned after fabrication by sandblasting, pickling and rinsing or other means and then shall receive a rust inhibitive phosphatizing or equivalent treatment prior to painting in accordance with applicable IS standard or article 20-6.6.1 of ANSI standard C37.20. Exterior surfaces shall then be primed, filled wherever necessary and given not less than two coats of quick air drying lacquer or synthetic enamel. Cubicles and terminal boxes for electrical devices shall be finish painted with semi-gloss finish in accordance with applicable IS standard or **ANSI Standard Indoor Light Gray No. 61** or as approved by Purchaser. Interior surfaces shall receive not less than one coat of corrosion resisting paint in accordance with the manufacturer's standard practice. Inside of cubicle shall be painted in approved colour by suitable quality paint.

10.3 Conforming Standards for Paints

The bidder shall submit the specifications and the names of manufacturers of all paints which will be incorporated into the work for approval of the purchaser. Paint shall dry with a surface such that touchup paint will adhere. Colour scheme will be approved by the purchaser.

11 CASTING

11.1 General Requirements



Castings shall be free from injurious defects and foundry irregularities such as projections, ridges, hollows and chip marks so that they will not require surface smoothing operations in the field prior to painting. The location of existing defects shall be determined and they shall be completely removed to sound metal. The structure of the castings shall be homogenous and free from excessive non-metallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting shall not be permissible and such casting shall be rejected. All castings involving welded fabrication shall be stress-relieved.

11.2 Dimensions of Castings

The thickness and other dimensions of the castings shall conform substantially to the dimensions on the drawings and shall not be reduced by shop or foundry practices to the extent that the resulting stresses in the metal will exceed the stresses allowed under this Document. Castings shall not be warped or otherwise distorted nor shall their dimensions be oversized to such an extent as to interfere with proper fit with other parts.

11.3 Surface Finish

All parts shall be free from burrs, sharp edges and imperfections after cutting, machining and welding. All visible parts shall receive special attention in order to ensure pleasing appearance of the complete equipment.

12 ELECTRICAL EQUIPMENT – GENERAL REQUIREMENTS

12.1 Electric Motors

- 12.1.1 All motors shall comply with relevant National or International Standards.
- 12.1.2 Supplier shall be fully responsible for ensuring that the motor duty cycle, rating, performance, tests and mechanical arrangements are all entirely relevant, suitable for compliance with the above standards for the application at the station in the extreme environmental and conditions specified.
- 12.1.3 The preferred type of A.C. motor is squirrel cage, totally enclosed, fan-cooled, except for single-phase motor with rating less than 0.5 kW. The standard types of motors would be subject to approval of purchaser. Motors above 1.0 kW shall be 3-phase type.
- 12.1.4 The stator insulation system shall be class-F or a higher class but in each case, temperature rises shall be limited to Class-F wherever practicable on full continuous rated load.
- 12.1.5 All A.C. motors shall be capable of direct on-line starting and of continuous operation at rated output under abnormal frequency conditions. These shall also be capable of operation for a period of not less than 5 minutes, with a voltage of 25 percent below nominal voltage at nominal frequency, without injurious overheating. The starting



- current at full voltage shall not exceed six times the full load current. Each motor shall be tested at Manufacturer's works to confirm compliance with this requirement.
- 12.1.6 Ball or roller bearings shall be used. Vertical shaft motors shall have approved thrust bearings. Lubrication fittings shall be provided for the bearings.
- 12.1.7 The terminal box shall be weatherproof and firmly fixed to the motor frame. The terminal studs shall be adequately sized for the current duty required and shall be identified. All terminal boxes shall have approved cable adapter plates, sealing chambers or conduit entries.
- 12.1.8 The arrangement of the terminal box shall be such as to facilitate installation of cables and allow interchanging of any two phase leads without disturbing the sealing compound, if this is used at cable terminations.
- 12.1.9 Wherever practicable, the motor end cover shall be removable from the driving end and shall have a removable plug to allow the speed to be checked by means of a portable tachometer.
- 12.1.10 All motors having a mass of 50 kg or more shall be fitted with lifting lugs.

12.2 Starters and Contactors

- 12.2.1 Motors starters and contactors shall be equipped with short circuit protection and local disconnected devices. All starters shall be preferably from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V Isolating transformer with primary circuit breaker and secondary fuses. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.
- 12.2.2 Starters and contactors shall comply with applicable IS standard or IEC 60947-4-1 or NEMA IC 1 and shall be suitable for direct on-line starting, uninterrupted electrical duty and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation, unless otherwise approved by the purchaser. The enclosures shall be complete with the locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards and other necessary items as required by the duty of the starter or contactors.
- 12.2.3 Starters & contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal voltage, at nominal frequency.
- 12.2.4 Thermal type over load and phase failure relays shall be supplied with starters for motors of 7.5 kW or higher rating. For motors of less than 7.5 kW rating, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to monitor current in one phase shall be provided for motors above 7.5 kW.
- 12.2.5 Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts.



12.3 Moulded Case Circuit Breakers (MCCBs) and Miniature Circuit Breakers (MCBs)

12.3.1 MCCBs

All moulded case circuit breakers shall be 2-pole or 3-pole, as required, having thermal time delay and instantaneous trips with provision for "On-Trip-Off" controls as well as suitable indications for these positions in the operating mechanism. The circuit breakers used in the motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with the applicable specification IEC 60947-2 or equivalent standards.

12.3.2 MCBs

All miniature circuit breakers shall be 2-pole or 3-pole, as required, having thermal time delay and instantaneous trips with provision for "On-Trip-Off" controls as well as suitable indications for these positions in the operating mechanism. MCBs shall be used in the supply control circuits, or on the secondary side of CTs & VTs. The breakers shall comply with the applicable specification IEC 60947-2 or equivalent standards.

12.4 Control Relays

Relays used as auxiliary control devices in conjunction with magnetic contactors shall be of the type designed for GIS application with provision for convertible contacts. All contacts shall have a minimum thermal current rating of 10 A over a range of 6 to 600 V AC.

12.5 Pilot Devices

12.5.1 Pilot devices such as selector switches, push-button switches & thermostats shall be of heavy duty type and where mounted outdoors, shall be housed in weatherproof enclosures specially designed for the extreme conditions of environment.

12.5.2 All electrical contacts for control, alarm and shutdown shall have a thermal current rating of not less than 10A at 220 V DC.

12.6 Instruments / Meters

12.6.1 The instruments mounted on panels shall be of the semi flush type, back connected, matching type, shape and of approved finish to present neat and fitting arrangement consistent with the functional requirements.

12.6.2 Mechanical quantity measuring instruments which are directly mounted on equipment shall have circular dials and shall be properly supported and guarded against accidental injury/breakage. These shall be placed in convenient location.

12.6.3 The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. The changes in the ambient temperature within the range prevailing at site shall not affect the accuracy.



- 12.6.4 The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale.
- 12.6.5 The instruments which make contacts shall have contacts suitable for 250 V AC or 220 V DC circuits.
- 12.6.6 All the instruments shall conform to relevant National or International applicable standards. They shall be subjected to type and routine tests prior to despatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V to ground (RMS) for one (1) minute as per the relevant standards.
- 12.6.7 The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at the rated voltage of the instrument. The coil rating of the measuring instruments shall be co-ordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade as far as accuracy class is concerned.

12.7 Terminal Blocks

- 12.7.1 All internal wiring to be connected to the external equipment shall terminate on blocks, preferably vertically mounted on the side of cabinet, junction box.
- 12.7.2 The terminal blocks to be provided shall be fully enclosed with removable covers. The Terminal Blocks shall be 650V / 1100V grade and shall have continuous rating to carry the maximum expected current. These shall be of moulded design made up of unbreakable polyamide 6.6, V0 grade, touch proof. All metal parts including screws should be non-ferrous in nature. The terminal blocks shall have screw locking design to prevent loosening of conductor /screw and withstand vibration level of 5g .All terminal blocks shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.
- 12.7.3 The Terminal Blocks for the current transformers and voltage transformers secondary leads shall be provided with sliding disconnect switch. All the testing & measuring operations shall be possible without removing the connections. All the metal parts for current transformer and voltage transformer terminal block shall be non-ferrous with fire fire retardant, unbreakable polyamide 6.6 of V0 class housing .All accessories as well shall be of similar material features. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.
- 12.7.4 At least **20% spare terminal** shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 12.7.5 The boxes shall be provided with **20% spare terminals** unless otherwise specified.
- Unless otherwise specified, terminal blocks shall be suitable for connecting the cables of following sizes on each side:



- | | | |
|----|-----------------------|---|
| a) | All circuit except CT | Min. two (2) Nos. 2.5sq.mm.
Copper flexible. |
| b) | All CT circuits | Min. of 4 nos. of 4.0mm ²
copper Flexible |
- 12.7.6 There shall be a minimum clearance of **250 mm** between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks shall be minimum of **150 mm**.
- 12.7.7 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Cabinet wiring should be suitable for 50 deg. C as the space heaters will keep the temperature 10 deg. C higher than the ambient.
- 12.7.8 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal is run parallel and in close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite to the wiring duct shall be reserved for the external cable connection. All adjacent terminal blocks shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cables.
- 12.8 Equipment Wiring**
- 12.8.1 Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilizing slip-on ferrules approved by the purchaser.
- 12.8.2 The markers provided may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.
- 12.8.3 The markers must withstand a tropical environment and high humidity. Only fungus-proof materials will be accepted. The ferrules of adhesive type are not acceptable.
- 12.8.4 All trip circuits shall employ markers having a red background.
- 12.8.5 Sensitive control circuits shall be effectively shielded against extraneous signals and interference. Separate terminals shall be provided for termination of individual cable shields which will be grounded at source end only.
- 12.8.6 All wiring connections shall be readily accessible and removable for test or other purposes. The wiring between the terminals of the various devices shall be point to point.
- 12.8.7 The splices or tee connections between terminal points are not acceptable. The wire runs shall be neatly trunked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipment.
- 12.8.8 **Multi-conductor copper cables 2.5 sq.mm for PT circuits and 4.0 sq.mm for CT circuits** shall be connected to the terminal blocks in such a manner as to minimise



crossovers. The claw washers or crimp type connectors used shall be of approved design & shall be used to terminate all small wiring. The grommets or insulating bushings shall be installed, where necessary.

12.9 Cubicles and Control Panels

- 12.9.1 The enclosures of cubicles and control panels shall be of **sheet steel with minimum thickness of 2.5 mm and gland plate shall be of minimum thickness of 3 mm**. These shall have rigid & self-supporting construction and supplied with channel bases.
- 12.9.2 The cubicles shall be fitted with close fitting, gasketed, hinged, lift-off doors capable of being opened through 180°. The doors shall be provided with integral lock and master key.
- 12.9.3 The cubicles and panels shall be vermin-proof. The gland plates of removable type shall be supplied and located in such a way so as to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor / roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by purchaser.
- 12.9.4 The cubicles and panels shall be adequately ventilated, if required, by vents or louvres and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.
- 12.9.5 Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.
- 12.9.6 Unless stated otherwise all the cubicles and panels shall be provided with a ground bus 40 Sq. mm copper bar extending throughout the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120 mm².
- 12.9.7 The standard phase arrangement when facing the front of the motor control centers and switchboards shall be RYB from left to right, from top to bottom and front to back. All the instruments, devices, buses and other equipment involving 3-phase circuits shall be arranged and connected in accordance with the standard phase arrangement, wherever possible. Electrical clearances shall conform to the applicable standards and shall not require cutting away of adjacent framework.
- 12.9.8 All the instruments, control knobs and indicating lamps shall be flush mounted on the panels. The devices sensitive to vibration shall not be installed on doors or hinged panels and no equipment shall be installed on rear of access doors.
- 12.9.9 The instrument and control wiring, including all the electrical interlocks and the interconnected wiring between sections shall be completely installed and connected to terminal blocks by the supplier.
- 12.9.10 The arrangement of control and protection devices on the panels and the exterior



- finish of the panels shall be subject to the approval of the purchaser. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.
- 12.9.11 Switched interior light and socket outlets shall be provided for all the cubicles and control panels.
- 12.9.12 All the cubicles and the control panels shall be provided with lamacoid name plates, non-rustic, identifying the purpose of the panel & all its components.
- 12.10 Alarm Contacts**
- 12.10.1 Wherever applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices:
- (i) Local annunciator
 - (ii) Station annunciator
 - (iii) Computerized Control System.
- 12.10.2 All alarm contacts shall be of changeover type. Wherever required, relays shall be provided as contact multiplier.
- 12.11 Earthing**
- 12.11.1 The earthing terminals for the equipment covered in these specifications shall also be included in the scope of supply. The supplier shall connect the earthing terminals to the grounding conductors available in the vicinity area of the equipment.
- 12.11.2 The earthing risers from the station earthing mat to the vicinity of equipment will be arranged by the purchaser unless specified otherwise.

13 QUALITY ASSURANCE PLAN (QAP)

3.1 Quality Assurance Programme

The supplier should adopt suitable quality assurance program to control all necessary activities to ensure that the equipment and / or services under the scope are in accordance with this specification. A quality plan detailing out the specific quality measure and procedures adopted for controlling the quality characteristics to be submitted for BHEL and PHPA approval.

The quality program is defined by ISO 9001, 1994 Quality systems- Model for quality assurance in design, development, production, installation and servicing.

13.2 Quality Assurance Test

- 13.3.1 A quality assurance plan detailing specific control procedures proposed to be adopted for controlling the quality characteristics for major items & equipment shall be furnished. The bidder shall submit and finalise manufacturing Quality Plans for all the major components and equipment with the purchaser. These quality plans will detail out various tests/inspections to be carried out and standards as mentioned in these specifications, various quality practices & procedures followed by bidder's Quality Control Organisation, the relevant reference documents acceptance norms



etc., various stages of material procurement, manufacture, assembly and final testing/performance testing etc. These shall include but not limited to the following:

- (i) Test of raw material.
- (ii) Non Destructive Tests as approved by Purchaser.
- (iii) Component Inspection and Tests.
- (iv) Assembly Inspection and Tests.
- (v) Pressure Test
- (vi) High Voltage Dielectric and other test
- (vii) Operational Tests
- (viii) Performance and efficiency tests as applicable.

- 13.3.3 The bidder shall furnish field quality plans which will detail out the quality practices & procedures etc. for all the equipment to be followed by the bidder's site quality control organization during various stages of site activities from receipt of material/equipment at site. The field quality plans shall also be approved by the PHPA/ BHEL.
- 13.3.4 No material shall be dispatched from the manufacturer's works before the same is accepted prior to pre-dispatch / final inspection including verification of records of all previous tests/inspection by PHPA/ BHEL's / their authorized representative duly authorized for despatch.
- 13.3.5 All the vendors/sub-vendors proposed by the bidder for procurement of major bought out items including castings, forgings, semifinished and finished components/equipments, list of which shall be drawn up by the bidder and finalized/approved in consultation with PHPA/ BHEL. The bidder's proposal shall include vendor/sub-vendor's facilities established at the respective works, the process capability, process stabilization, Q.C. system followed, experience list etc. along with their own technical evaluation of vendor/sub-vendors and shall be submitted to the purchaser for approval prior to any procurement. The approval for such vendor/sub-vendor shall not relieve the bidder from any obligation, duty or responsibility under the contract. This action shall, however, not involve PHPA/ BHEL in any complications arising between the bidder and his sub-contractor(s)/vendor/sub-vendors from whom he proposes to procure the material and submit their quality plans for PHPA/ BHEL's approval.
- 13.3.6 Normally no request for change of vendors/sub-vendors shall be entertained by PHPA/ BHEL. But in the peculiar circumstances if the request for change of vendors/sub-vendors is found reasonable and justified then the same shall be entertained and the decision of PHPA/ BHEL in this respect shall be final and binding. The time consumed for the change of vendors/sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the bidder from the responsibility to complete the work within stipulated time in any manner.



- 13.3.7 The quality requirements as agreed for the main equipment supply shall be applicable for the replacement items and all the spares as required.
- 13.3.8 All materials used or supplied shall be accompanied by valid & approved material certificates and tests & inspection reports. These certificates and reports shall indicate the acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

14 DEVIATIONS FROM SPECIFICATIONS

All the deviations from the specifications shall be separately listed in Performa enclosed with respective sections of this Document, in the absence of which it will be presumed that the provisions of the specifications have been fully complied with by the bidder.

15 PACKING AND FORWARDING

- 15.1 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The bidder shall be responsible for any damages to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by bidder without any extra cost. The replacement of damaged equipment shall be made promptly in order to complete the work within specified schedule and without waiting for the settlement of insurance claim.
- 15.2 The outside of the Box shall have the following details:
- Name of Contract Agreement Number
 - Name of the consignee
 - Name of Supplier
 - Total weight of consignment
 - Sign showing top/bottom side of the Box
 - Storage Code/ Symbols
 - Handling and unpacking instructions
 - Packing List of the material.
- A copy of detailed packing list shall also be kept inside the Box.
- 15.3 All removable external accessories and other components susceptible to damage if transported mounted on the equipment, shall be dismantled, adequately packed and shipped separately. All openings thus resulted shall be sealed by means of temporary steel plates (blanks).
- 15.4 Packing shall be sturdy and adequate to protect all assemblies, components, auxiliary devices and accessories from injury by corrosion, dampness, heavy rains, breakage and vibration encountered at the plant site.



- 15.5 Mandatory Spare parts and Tools & Tackles required for Operation & Maintenance shall be packed separately and clearly marked.

16 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

- 16.1 All the equipment, apparatus, materials and supplies covered under the specification shall be subjected to test in the shop and at the field In the presence of the representatives of PHPA / consultants/ BHEL for conformity with the requirements of the specifications. The method and procedure for the tests shall be as specified for particular item or shall be in conformity with the applicable standards for making such tests. The details of the test procedures and test equipment to be used should be intimated well in advance i.e. at least 6 weeks before these tests are conducted.
- 16.2 The end customer (PHPA)/ BHEL, his duly authorised representative and/or outside inspection agency acting on behalf of purchaser shall have at all reasonable times access to the supplier's premises or works and shall have the power to inspect and examine the materials and workmanship of the works during its manufacture or erection. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The equipment, if found unsatisfactory at any stage as to workmanship or material is liable to be rejected.
- 16.3 The test reports shall indicate the tests performed, the results obtained, instruments used, names of personnel carrying out the tests and provision for signature of the witnesses. They shall also show the test report number and the date of conducting the test. The format of these reports shall be submitted alongwith testing procedures for the Purchaser's (PHPA)/ BHEL approval well in advance.
- 16.4 All services such as labour, materials, electricity, fuel, water, stores, apparatus and instruments required for conducting any or all tests shall be arranged & provided by the supplier at his cost.

The price of conducting all tests and additional type tests is deemed to be included in Bid price.

1.15 TRANSPORTATION, HANDLING, STORING AND INSTALLATION

The Bidder is required under the Contract to undertake transportation of goods from FOB/Ex-works to Project Site including clearing, forwarding and handling at port of entry, storage and preservation at site, intermediate location (if any) and further transportation to work site, including handling wherever required. All necessary transportation equipment including lifting and handling equipment shall be provided and/ or hired by the Bidder at his own cost.

Where the Bidder is required to effect delivery under any other terms, for example, by post or to another address, the Bidder shall be required to meet all the expenses until delivery on the site.

Where assemblies are supplied in more than one section, bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses.



Bidder shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the bidder at his own expenses.

1.16 DOCUMENTATION

1.16.1 DRAWINGS

All drawings shall be prepared in AutoCAD and ultimate documentation would include drawings/documents on CDs. All dimensions and data shall be in SI metric units.

All items of the equipment should be clearly identified by proper part nos. in the contract drawings. Such parts, which are to be dispatched to site from works in dispatchable units and are reassembled at site, should be marked by proper identification marks at works and indicated in the drawings and quantified. The shipping list should be sent along with the general arrangement drawings for engineer's approval. All the items of the shipping list should be identified in the drawing.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at supplier's risk.

Approval of drawing or work by the purchaser/consultant shall not relieve the bidder of any of his responsibilities and liabilities under the contract.

In case of any modifications that may be necessary during erection or commissioning of the equipment, the bidder shall carry out modifications in the original drawing & submit 'As Built drawings' and required no. of prints thereof.

1.16.4 DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A	For Approval (7 Sets – each revision), Hard copies as well as soft copies
07	Copies of GA drawings with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
07	Copies of type test reports
07	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.



Project: 6X200 MW PUNATSANGCHHU-I HEP & 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN
Customer: PHPA-I & II BHUTAN

Technical Specification
Section-3: Project Details & General Specifications

Doc No: TB-356-316-0XX
Rev. No. 00

07	Copies of manufacturing and field quality plan.
07	Copies of installation, operation & Maintenance manual.
B	After Approval and For Information/Distribution (5 Sets).
05	Copies of GA drawings
05	Copies of type, Routine & Acceptances manual.
05	Copies of Insulation, Operation & Maintenance manual.
05	Set's of 'As Built' drawings
01	Sets of RTF of all drawings
02	All drawing/documents AS BUILT on CD-ROM.

NOTE:

1. Any revision of drawings / documents shall be submitted in the same no. of copies submitted first time for approval
2. Final drawings / documents shall be submitted in bound volume with customer and project details etc. written on the top.



SECTION 4

GUARANTEED AND TECHNICAL PARTICULARS FOR 390kV & 216kV SURGE ARRESTER

(To be filled for each voltage class surge arrester separately)

1.0 GENERAL

- | | |
|------------------------------------|----|
| a) Manufacturer's Name | a) |
| b) Manufacturer's type designation | b) |
| c) Applicable standards | c) |

2.0 ELECTRICAL CHARACTERISTICS

- | | |
|--|----|
| a) Arrester class and type | a) |
| b) Rated arrester voltage (kV) | b) |
| c) Maximum continuous operating voltage (COV) at design ambient temperature | c) |
| d) Nominal discharge current (8/20 micro sec. Wave) (kA) | d) |
| e) i) Minimum discharge capability (kJ/kV) referred to rated voltage at minimum of discharge characteristics | e) |
| ii) Line Discharge class, as per IEC | e) |
| f) Maximum equivalent front of wave protection level (discharge voltage with 0.5 x 1.5 micro sec. 10 KA impulse current) | f) |
| g) i) Minimum switching surge residual voltage, at 1 KA (kVp) | g) |



ii) Maximum switching surge residual voltage at 1 kA (kVp)	ii)
h) Maximum residual voltage for 8/20 micro sec current wave	h)
i) at 50% nominal discharge current (kVp)	i)
ii) at 100% nominal discharge current (kVp)	ii)
iii) at 200% nominal discharge current (kVp)	iii)
l) One minute power frequency (dry) withstand voltage of arrester (kV rms)	i)
j) Impulse withstand test voltage of arrester housing with 1.2/50 micro sec wave, (kVp)	j)
k) Impulse current withstand	k)
i) High current short duration (4/10 micro sec. Wave) kAp	i)
ii) Low current long duration (A peak)	ii)
l) Maximum internal ionisation at 50 Hz voltage equal to	l)
i) 1.05 COV	i)
ii. 1.0 COV	
m) Reference voltage and corresponding reference current of arrester	m)
n) Maximum internal leakage current at (W/kV)	n)



i) COV	i)
ii) 1.1 COV	ii)
iii. COV at 150 deg. C	iii)
iv. Reference voltage	iv)
o) Pressure relief class	o)
p) Are the protection levels affected by pollution of external insulation	p)
q) Energy absorption capability in kJ per operating of the arrester, during a switching surge discharge	q)
r) Maximum amount of energy that may be dispatched into the arrester during discharge assuming that discharge takes place within 1 min period and state the switching surge current	r)
s) Internal pressure required to operate pressure relief device as a percentage of burst pressure of porcelain	s)
t) Dynamic overvoltage withstand kVp	t)
i. For 3 peaks	i)
ii. For 0.01 sec.	ii.
iii. For 0.1 sec.	iii.
iv. For 1 sec.	iv.
u) Minimum prospective symmetrical fault current	u)
v) Rejection rate of ZnO blocks during manufacturing	v)



and operation for the past
three years (%) separately

w) Rated voltage of ZnO
disc (kV)

w)

l) No. of ZnO discs in a unit

l)

ii. No. of units/ arrester

ii)

iii) Height/ Thickness of ZnO discs (mm)

iii)

iv) Diameter of ZnO disc (mm)

iv)

3.0 EXTERNAL INSULATION

a) Type

a)

b) Applicable standard

b)

c) Impulse voltage withstand test
voltage of housing with 1.2/50 microsec wave (kVp)

c)

d) One minute power frequency
withstand voltage of arrester
housing dry & wet (kV rms)

d)

e) Total creepage distance of
arrester housing (mm)

e)

f) Cantilever strength of
complete arrester (kg)

f)

4.0 OVERALL DIMENSIONS

a) Overall dimensions

a)

i. Overall Height (mm)

i.

ii. Height upto top of
terminal pad from mounting plane

ii.

iii. Material of terminal pad

iii.



- | | |
|--|-----|
| iv. Size of terminal pad | iv. |
| v. Mounting dimensions
and diameter of mounting holes | v. |
| vi. Diameter of insulator | vi. |
| b) Total weight of complete
arrester (kg) | |

TERMINAL CLAMPS AND CONNECTORS

- | | |
|---|-------|
| 1. Manufacturer's Name | 1. |
| 2. Applicable Standards | 2. |
| 3. Type | 3. |
| 4. Material of connector | 4. |
| a) Clamp body | a) |
| b) Bolts & Nuts | b) |
| c) Spring washers | c) |
| 5. Rated current | 5. |
| 6. a) Rated terminal load (kg) | 6. A) |
| b) Factor of safety | b) |
| 7. Minimum thickness of any part (mm) | 7. |
| 8. Weight of clamp complete
with hardware (kg) | 8. |
| 9. Type test reports as per IS enclosed | 9. |
| 10. OGA drawing enclosed | 10. |

BUSHING/ SUPPORT INSULATOR

- | | |
|-------------------------|----|
| 1. Manufacturer's Name | 1. |
| 2. Type | 2. |
| 3. Applicable Standards | 3. |



4.	I. Height	4.
	ii. Diameter (Top)	ii.
	iii. Diameter (Bottom)	iii.
5.	Total Creepage distance (mm)	5.
6.	Rated voltage (kV)	6.
7.	Power frequency withstand voltage for 1 min. (kV rms) dry and wet	7.
8.	1.2/50 micro sec. Impulse withstand voltage (kVp)	8.
9.	250/2500 micro sec. Switching impulse withstand voltage (kVp) dry and wet	9.
10.	Corona Extinction voltage (kV)	10.
11.	Weight (kg)	11.
12.	Max. allowable span (mm)	12.
13.	Cantilever Strength (kg)	13.
14.	OGA drawing enclosed	14.



SECTION – 5

Check List

1. TECHNICAL REQUIREMENTS (FOR SURGE ARRESTER)

S. No.	PARTICULARS	Unit	390 kV		216 kV	
1.	Designation	-	Heavy duty, Station class, gapless type			
2.	Application	-	Surge protection of transformer/ Reactor/ long lines			
3.	Type	-	Metal Oxide, Gapless			YES/NO
4.	Installation	-	Outdoor			
5.	Rated System voltage	kV	420	YES/NO	245	YES/NO
6.	Arrester Rated Voltage	kV	390	YES/NO	216	YES/NO
7.	Cont. Operating Voltage (MCOV) at ambient temperature	kV _{rms}	303	YES/NO	168	YES/NO
8.	Rated Frequency	Hz	50			YES/NO
9.	Rated nominal discharge current for 8/20 μ s wave	kA	10	YES/NO	10	YES/NO
10.	Minimum discharge capability	kJ/kV	10	YES/NO	10	YES/NO
12.	Maximum switching surge level at 1kA	kV _p	780	YES/NO	-	YES/NO
13.	Maximum discharge voltage at 10kA	kV _p	1050	YES/NO	795	YES/NO
14.	One minute dry/ wet power frequency withstand test voltage for arrester housing	kV _{rms}	630	YES/NO	460	YES/NO
15.	Lightening impulse withstand Voltage of arrester housing	kV _p	1425	YES/NO	1050	YES/NO
16.	Switching Surge withstand Voltage of arrester housing	kV _p	1050	YES/NO	-	YES/NO
17.	Long duration discharge class		3	YES/NO	3	YES/NO
18.	Current for pressure relief test	kA _{rms}	50	YES/NO	40	YES/NO
19.	Min. total creepage distance	mm	10500	YES/NO	6125	YES/NO
20.	Prospective symmetrical fault current for 1 sec	kA	50	YES/NO	40	YES/NO
21.	Pressure relief class		Class A of table VII of IS 3070 or equivalent IEC			YES/NO
22.	RIV at specified power frequency voltage	μ V	Less than 1000 at 266 kV _{rms}	YES/NO	Less than 500 at 156kV _{rms}	YES/NO
23.	Partial discharge at 1.1 Un/ $\sqrt{3}$	pC	Not more than 10			YES/NO



24.	Minimum Cantilever Strength of complete arrester	Kg	500	YES	500	YES
25.	Suitability to Hot Line Washing			YES		YES
26.	Potential free contact in surge counter	Provided		YES		YES
27.	Degree of Protection for Surge counter	IP55		YES		YES
28.	Parts/ Accessories to be supplied with SA as mentioned below but not limited to it.			YES		YES
i)	Surge Counter			YES		YES
ii)	Insulating base			YES		YES
iii)	Corona ring and/ or grading ring (if applicable)			YES		YES
iv)	Hardware required for inter-unit connection and to connect the surge arrester to structure			YES		YES
v)	Insulated interconnecting cable between arrester and surge monitor. (cables for all SA at a station supplied in single length)		5m for each SA	YES	5 m for each SA	YES

2. TYPE TESTS

Whether Type test reports of the tests conducted earlier (not more than ten years earlier) from the date **09.02.12 for PHPA-1 & 08.04.2013 for PHPA-2** on similar material available.

YES/NO

If the valid type tests reports are not available with the bidder then the tests as per relevant IS/IEC shall be conducted by the bidder free of cost.

YES