BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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		DATE	30/08/14	30/5	
400 kV WAVE TRAP		GROUP	TBEM	W.O. No	83005

CUSTOMER	PUNATSANGCHHU-II HYDROELECTRIC PROJECT AUTHORITY, BHUTAN
CONSULTANT	WAPCOS LIMITED, CENTRAL ELECTRICALS LTD.
PROJECT	PUNATSANGCHHU-II HEP (6X170MW) – 400kV POTHEADYARD

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SECTION 1
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 400kV Wave Traps complete with accessories as listed under this specification.

This section covers the specific technical requirements of Wave Trap. This constitutes minimum technical parameters for the above item as specified by the customer (PHPA-II, Bhutan). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:

Section-1: Scope, Specific Technical Requirements & Bill of Quantities
Section-2: Equipment Specification
Section-3: Project Details & General Technical Requirements
Section-4: Guaranteed Technical Particulars
Section-5: Checklist

- In case of any conflict between various sections, **order of precedence** shall be in the same order as listed above.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of customer: Punatsangchhu-II Hydroelectric Project Authority, Bhutan

Name of consultant: WAPCOS Limited, Central Electricity Authority

Name of Project: Punatsangchhu-II HEP (6X170MW) - 400kV Potheadyard

Refer Section - 3 for Project Details and General Specifications.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

1.2.1 As per attached annexure-I (PHPA-II specification), 3 pages.

1.2.2

Sl. No.	Technical Parameters	Unit	Value for		
			400 kV	~~**220 kV**~~	~~**132 kV**~~
1	Max operating voltage of the system	kV rms	420	~~245~~	~~145~~
2	Rated short time current for 1-second	kA	50	~~40~~	~~31.5~~
3	Nominal discharge current of protective device	kA	10 (However, co-ordination shall be done by taking 20 kA discharge current into account)		
4	Type of tuning		Broad Band		
5	Rated Blocking bandwidth		Typically in the range 50-500 kHz*		
6	Capacitance of CVT	pF	4400/~~6600/8800~~		
7	Max Radio Interference Voltage level	µV	≤2500 (for 266 kVrms)	~~≤500 (for 156 kVrms)~~	~~500 (for 97 kVrms)~~
8	Rated power frequency	Hz	50		
9	Resistive component of impedance within Carrier frequency blocking range	ohms	Not less than 450 ohms		
10	Min Corona extinction voltage level	kV rms	320	~~156~~	~~105~~

***If required, two tuning pots to be offered to meet design requirements.**

1.3 QUANTITIES

Sl. No.	Description	Quantity at 400 kV PHPA-II Potheadyard
1.	400kV, 2000 A, 50 kA/1 sec, 1.0 mH Wave Trap suitable for pedestal mounting	15 Sets
2.	Terminal Connectors for line side of 400 kV Wave Trap (suitable for Twin MOOSE conductor*)	15 Sets
3.	Terminal Connectors for station side of 400 kV Wave Trap (suitable for Twin MOOSE conductor*)	15 Sets

Each Wave Trap is required with following **accessories**

(a) Hardware (Nuts, Bolts and Washers) for mounting Wave Trap – 1 set with Each Wave Trap
(b) Grading ring, if necessary – 1 set with Each Wave Trap

* The final requirements of terminal connectors will be furnished to the successful bidder during contract stage.

1.4 TYPE TESTS

The offered equipment should have been successfully type tested as per relevant IS/IEC and valid test reports shall be submitted. Bidder shall submit valid reports of type tests for Wave Trap, carried out within last ten years from 09.02.12. If these tests have been conducted more than ten years prior to the abovementioned date or do not have valid test report, the type test shall be repeated with no extra cost to BHEL/PHPA.

1.5 INSPECTION & TESTING

Before being fitted on the equipment, all components shall be subjected to routine tests at the Contractors factory, as per the relevant IEC/IS standards. A detailed test report proving the successful passing of such tests shall be provided.

Prior to dispatch, the routine & acceptance tests shall be carried out on each Wave Trap in accordance with the applicable IEC /IS and the material shall be offered for final inspection to BHEL and PHPA in accordance with agreed quality plan with 3 weeks advance information.

Type test reports on identical rating shall be submitted for approval. In event of non-acceptability of submitted test reports on technical grounds at the contract stage, the type tests shall be conducted at no additional cost.

1.6 QUALITY PLAN

The contractor shall carry out contract works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Contractor shall submit detailed Quality Plan for BHEL / customer's approval.

ANNEXURE - I

6.4.4.2.9 The Bidder shall furnish during design stage report containing the technical justification and calculations in support of the selection of the location and other technical parameters of the Surge Arrester. This study report should highlight the technical comments on the proposed rated voltage, the long duration class and the energy handling capacity.

6.4.5 WAVE TRAPS

6.4.5.1 Type & Ratings

6.4.5.1.1 Each Wave Trap offered shall meet the requirement of IEC 353, IS:8792, 8793, 9859 (Part I) including their latest amendments. The frequency details of the blocking band of the wave trap shall be given at the time of execution of the order. However, the Wave Traps shall have following parameters & ratings

S. No.	Particulars	400kV System
a)	Nominal system voltage (kV)	400
b)	Max. system voltage (kV)	420
c)	Rated continuous current (A)	2000
d)	Rated short ckt current for 1 sec (kA)	50
e)	Radio interference voltage at 266 kV_{rms}	≤ 500 µV
f)	Minimum resistive Impedance (Ω)	450
g)	Nominal discharge current of Protective device (kA)	10
h)	Rated inductance (mH)	1.0
i)	Blocking Band	To be indicated by the contractor

6.4.5.2 Construction Details

6.4.5.2.1 Wave Trap shall be of outdoor mounting type supported on post insulators with incoming and outgoing clamps and other required accessories for installation as well as various connections in the Pothead Yard. The connectors shall be suitable for connecting Tubular conductor or twin moose ACSR conductors for 400kV system.

6.4.5.2.2 The effect of magnetic flux shall be nullified. No magnetic material shall be used in Wave Trap. All the accessories, clamps and other parts of Wave Traps shall be of non-magnetic material.

6.4.5.2.3 The Wave Trap shall be fitted with top and bottom clamp connectors, bird barriers and shall be supplied with all accessories. All iron parts shall be hot dip galvanized.

6.4.5.3 Technical Requirements

6.4.5.3.1 Line Traps consisting of a main coil in the form of inductor, a tuning device and a protective device shall be inserted into transmission line to prevent undue loss of

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carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.

6.4.5.3.2 Line Trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with protective and tuning devices.

6.4.5.3.3 Wave Trap shall be broadband tuned for its entire carrier frequency range. Resistive component of impedance of the wave trap within its carrier frequency blocking range shall not be less then 450 ohms for 400 kV systems.

6.4.5.3.4 Wave Trap shall be provided with a protective device in the form of Surge Arrestors which shall be designed and arranged such that neither significant alteration in its protective function nor physical damage shall result temperature rise to the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, when power frequency voltage developed across the Wave Trap by the rated short time current. The lightning arrestor shall be station class current limiting active gap type. Its rated discharge current shall be 10kA. Bidder has to furnish full justification in case he recommends the use of gap-less metal oxide arrestor.

6.4.5.3.5 Wave Trap on 400kV lines shall show no visual corona discharge at a voltage of $320kV_{rms}$ power frequency voltage. Suitable corona rings may be incorporated in the Wave Traps. Radio interference voltage for 400kV shall not exceed 1000 microvolts at $266kV_{rms}$

6.4.5.3.6 The Bidder shall indicate continuous current rating of the trap at an ambient temperature of $35^{\circ}C$.

6.4.5.4 Wave Trap Mounting

6.4.5.4.1 The Wave Trap shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind. For pedestal mounting, each Wave Trap shall be mounted on a lattice type steel structure formed by three insulator stacks arranged in a triangular form. The Bidder shall supply all the accessories and hardware including concrete foundation bolts and bolts for fixing the Wave Trap on insulator.

6.4.5.5 Terminal Connectors

6.4.5.5.1 The Wave Traps shall be suitable for connecting to tubular conductors of adequate size or twin Moose ACSR conductors as applicable with horizontal or vertical take off. The Contractor shall supply necessary connectors. Terminal Connectors shall conform to IS: 5561.

6.4.5.5.2 No part of clamps & connectors (including hardwares) shall be of magnetic material. Clamps and connectors shall be designed corona controlled.

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6.4.5.5.3 Clamps/connectors shall be designed for the same current rating and temperature rise as of Wave Traps.

6.4.5.6 Terminal Boxes

A terminal box alongwith necessary glands for receiving control cables suitable for mounting on the bottom plate shall be included in the scope of supply. A door with locking arrangements shall be provided in the front of the terminal box so as to permit easy access to the secondary terminals. The door shall have suitable arrangement to check ingress of moisture into the terminal box. The terminal boxes shall be suitable for outdoor installation and shall conform to IP-55 protection class.

6.4.6 BAY MARSHALLING KIOSKS

6.4.6.1 One no. marshalling kiosk shall be provided for each bay of 400kV out going line feeders.

6.4.6.2 The marshalling kiosks shall be of steel construction, outdoor type, IP-55 protection class, weather and vermin-proof and shall be provided with locks and latches. The marshalling kiosks shall have sloping roof and shall be provided with lifting lugs. Each marshalling kiosk shall be self-supporting type and shall be provided with appropriate number of foundation bolts for fixing it. Sheet steel used shall be at least 2.0mm thick cold rolled / 2.5mm hot rolled and properly braced to prevent wobbling. If the equipment within the marshalling kiosk is not easily accessible from the ground level, the foundation of the marshalling kiosk shall be so designed that the person can stand on the foundation for operating the equipment.

6.4.6.3 Marshalling kiosks shall be provided with double-hinged doors with padlocking arrangement. The distance between two hinges shall not exceed 350mm to ensure uniform sealing pressure against atmosphere.

6.4.6.4 The cable entries to the marshalling kiosk shall be from the bottom. Suitable cable gland plate, projecting at least 150mm above the base of the marshalling kiosk shall be provided for this purpose. Necessary number of cable glands shall be supplied and fitted to the terminal boards provided in the kiosk. The gland plate shall have provision for some spare glands for future cabling to be provided later, if required. The cable glands shall be dust proof screw on, double compression type and made of brass.

6.4.6.5 Suitable thermostatically controlled heaters shall be mounted in every compartment of kiosk to prevent condensation. On-off switches and fuses shall be provided with each space heater. Heater shall be suitable for 240 V AC supply. Provision of illumination lamps with door control switches shall also be made in each kiosk.

6.4.6.6 Marshalling kiosk shall be supplied complete with interconnection wiring provided between all electrical devices mounted in the Pothead Yard and protection panels mounted in the local panel room. All internal / external wiring shall be carried out with 1100V grade FRLS, PVC insulated 6 mm^2 and 4 mm^2 copper conductor for CT

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SECTION-2

EQUIPMENT SPECIFICATION

2.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and despatch of Line Traps. No deviation from the requirements specified in various clauses of this specification shall be allowed.

2.1 APPLICABLE STANDARDS

The Line Traps shall comply with applicable parts of the following standards, except as otherwise specified herein:

IEC: 60099(Part –1 and 4)	Surge arrester
IEC: 60353	Line Trap.
IS 8792	Line Traps.
IS 8793	Method of Tests for Line Trap.
IEC : 60	High Voltage Test Techniques.
IS 3070 (Part I)	Specification for Surge Arresters for AC System.
IS 5561	Specification of electric power Connectors.

The equipment shall also meet with following International publication on the subject:

CIGRE	319- 1962
CIGRE	35-01-1974
IEEE (USA)	Vol.83 No.7 PAS

The equipment shall conform to the latest applicable standards and their amendments.

2.2 FEATURES

1. Line trap shall be inserted into high voltage transmission line to prevent undue loss of carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.

2. The Line Traps shall be broadband type tuned for its entire carrier frequency range. Resistive component of impedance within carrier frequency blocking range shall not be less than 450 ohms or else specified.

3. Line trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be provided with a protective device and a tuning device. Also suitable corona rings shall be provided to meet corona and radio interference performance.

4. Line Trap shall be provided with a protective device in the form of surge arrester which shall be designed and arranged such that neither significant alteration in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage developed across the line trap by the rated short time current. The protective device shall be shunt connected to the drain coil and tuning device.

5. The surge arrester shall be station class current limiting ~~active gap /~~ gap-less type. Its rated discharge current shall be 10 ~~/ 20~~ kA. Co-ordination, however, shall be done by taking 20kA at 8/20 micro sec discharge current into account. Bidder has to furnish full justification in case the gap-less metal oxide arrester is recommended at contract stage. The SA provided with line trap of each rating shall fully comply with the requirements of IS 3070 Part-I/ IEC-60099-1Part-1/IEC-60099-4. The SA provided with the line trap shall be subjected to routine and acceptance tests as per IEC-60099-1 (Part-1) /IEC-60099-4.

6. The Line traps shall be equipped with suitable bird barriers and shall be painted.

7. WELDING

All the welding included in the manufacture of line traps shall be performed by personnel and procedure qualified in accordance with ASME-IX and all the critical welds shall be subjected to NDT as applicable.

8. MOUNTING

The Line traps shall be suitable for outdoor pedestal ~~or suspension~~ mounting and shall be mechanically strong to withstand the stresses due to wind pressure of 260 kg/sq m. All the accessories, mounting stools and hardware including bolts for fixing the line trap on insulators shall be of non-magnetic material and shall be supplied by bidder. For pedestal mounting, it shall be mounted on a tripod structure formed by three solid core bus post insulators.

9. TERMINAL CONNECTORS

The Line Traps shall be suitable for connecting to 4" / 4.5" IPS Aluminium tube or ACSR bundle/Tubular conductor with horizontal or vertical take off. Necessary connector shall be supplied by the bidder.

Terminal Connectors shall conform to IS:5561.

No part of clamp or connector (including hardware) shall be magnetic material.

All castings shall be free from blowholes, surface blisters, cracks and cavities. All sharp edges shall be blurred and rounded off.

Clamps and connectors shall be designed corona controlled. All nuts and bolts shall be suitably shrouded.

Clamps/connectors shall be designed for the same current ratings as line trap and temperature rise shall not exceed 35.deg. C over 50.deg. C ambient. No current carrying part shall be less than 10mm thick.

Clamps / connectors shall conform to type test as per IS:5561. Type Test reports shall also be submitted for following additional tests at contract stage:

a) Visual Corona Extinction Test (shall not be less than 320 kV rms)
b) Radio Interference Voltage Measurement (shall not exceed 500 microvolts at 280 kV rms)

2.3 RATING PLATE

Each Line Traps shall be provided with anodized aluminium rating plate of thickness not less than 2 mm, secured permanently on the main coil, tuning device and protective device as per clause 15 of IEC: 353.

In addition to above requirements, the name of ultimate customer & BHEL shall be given on the rating plate.

2.4 TESTS

The Line Traps, Connectors & Surge Arresters shall be accompanied by Type, routine and acceptance testing as per latest IS/ IEC standards.

Bidders shall submit valid reports of type tests carried out within ten ~~/ five~~ years of bid opening at contract stage. These reports should have been conducted on identical / similar equipment to those offered, in case less than ten ~~/ five~~ years old type test reports OR valid type tests are not furnished, the tests shall be conducted free of charge. No separate type test charges shall be paid.

All valid type test reports as per latest IS/ IEC for Line Traps shall be submitted for approval at contract stage, which shall include the following
a) Short time current & peak withstand test.
b) Temperature rise test.
c) Corona extinction voltage test
d) Radio Interference Voltage test
e) Measurement of Inductance of main coil
f) Insulation Test

The SA provided with the WT of each rating shall fully comply with the requirement of IS: 3070 Part-1 & IEC-60099-1/IEC-60099-4. It shall conform to type tests as applicable & type test certificate for the same shall be submitted by the Bidder for approval. The SA provided with Line Trap shall be subject to routine & acceptance tests as per IEC-60099-1/IEC-60099-4.

Bidder shall also submit type test charges for conducting type tests on Line Traps, Connectors & Surge Arresters in the event of these tests being conducted even after availability & approval of valid type tests reports. Such tests shall be conducted on payable basis.

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 Punatshangchhu, 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 Punatshangchhu, 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-II), 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

		(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

		PHPA-1	PHPA-2
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

		PHPA-1	PHPA-2
a). Minimum Temperature	:	4.0°C	4.0°C
b). Maximum Temperature	:	35°C	40°C
c). Design Ambient Temperature	:	40 °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 ± 3 %	50 ± 3 %	NA
4.	Voltage variation	± 10 %	± 10 %	± 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 CLEARENCE

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

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, not withstanding 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 indicatintions 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 180^0. 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 mm^2.

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.

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:

a) Name of Contract Agreement Number
b) Name of the consignee
c) Name of Supplier
d) Total weight of consignment
e) Sign showing top/bottom side of the Box
f) Storage Code/ Symbols
g) Handling and unpacking instructions
h) 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.

17 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

18 DOCUMENTATION

18.1 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.

18.2 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.
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 TECHNICAL PARTICULARS

	WAVE TRAPS	400 kV
1	Name of manufacturer and country	:
2	Type Model and Catalogue No	:
3	System Voltage Rating	:
4	Continuous current rating at 50° C ambient	:
5	Continuous current rating at 65° C ambient	:
6	Maximum Symmetrical short circuit current rating for 1 sec Duration	:
7	Asymmetric peak value of first half wave of rated short time current	:
8	Rated Inductance	:
9	Blocking Range	:
10	Minimum Guaranteed Resistive Component in Blocking frequency range	:
11	Type of Tuning	:
12	Variation in 50Hz Impedance per Degree Centigrade variation in ambient temperture	:
13	Variation in Resonant frequency band per degree centigrade variation in ambient temperature	:
14	Details of protection of capacitors and coils against voltage surges indicate type of protective device.	:
15	Basic Insulation level	:
16	Standard Nominal Discharge Current of Protective Device for 8/20 Micro second wave impulse	:
17	Rated voltage of the Arrestor (Protective device)	:
18	Min. value of power frequency sparkover voltage (Dry and wet) of protective devices	:
19	Maximum 1.2/50 usec Impulse Sparkover voltage of protective device	:

GUARANTEED TECHNICAL PARTICULARS

20	Virtual steepness and max front of wave impulse sparkover voltage of protective device	:
21	Max. residual discharge voltage of protective device for 8/20 usec impulse discharge current of	
	(a) 5000 Amps	:
	(b) 10000 Amps	:
22	Class of Insulation of line traps as per table - 1 of IEC 353	:
23	Temperture Rise in line trap under rated continuous current	:
24	Visual corona Extinction voltage	:
25	Radio Interference voltage	:
26	Type of incoming and outgoing terminals	:
27	Visual corona Extinction voltage for terminal concurrence	:
28	Radio interference voltage in terminal connectors	:
29	Continuous current rating of terminal connector at 50° C ambient	:
30	Short time current rating of terminals connectors	:
31	Temperature rise in terminal connector under rated continuous current over 50° C ambient	:
32	Type of Mounting	:
33	Maximum working stress	:
34	Ultimate tensile strength	:
35	Material of main coil	:
36	Material of terminal connector	:
37	Material of pedestal	:
38	Material of mounting hardware	:
39	Net weight (Approx)	:
40	Whether corona rings are provided	:
41	Whether Bird Barries are provided	:
42	Overall Dimensions provided	
	(a) Diameter	:
	(b) Height	:
43	Any other feature	:
44	No of turns in theline trap main coil	:

GUARANTEED TECHNICAL PARTICULARS

45	Type of conductor whether solid or standard	:
46	Overall conductor size	:
47	Cross sectional area of conductor of one layer	:
48	Type of construction (no of coils and whether open type or covered with insulating material	:

SECTION-5

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BHEL ENQUIRY. NO:

BIDDER OFFER REFERENCE:

A)

S.No.	Parameters	Data	Yes / No	Remarks
		400 kV Wave Trap		
1.	Applicable Standard	IEC: 60353 with amendment, IS:8792, IS: 8793, IEC: 60099 (Part I&IV), IS : 3072 (Part -I) and IS : 5561		
2.	Type			
3.1	Rated Inductance	1.0 Mh		
3.2	Rated Frequency	50 Hz		
3.3	System Voltage	400 kV		
3.4	Rated current	2000 Amp		
3.5	Rated Short Circuit Current	50kA for 1 sec.		
3.6	Tuning device type (Indentor to tick)	Factory fixed / Field adjustable		
3.7	Type of tuning	Broad Band		
3.8	Tuning range	50 to 500 kHz		
3.9	Minimum resistive component of impedance within the rated blocking band-width	Not less than 450 ohm		
3.10	Visual Corona Extinction voltage	Not less than 320 kV (rms) (for 400 kV)		

S.No.	Parameters	Data	Yes / No	Remarks
3.11	Radio Interference voltage	Not exceed 2500 μV at 266 kV (rms) (for 400 kV)		
3.12	Material of main coil	Non magnetic		
3.13	Mounting arrangement	Pedestal mounting		
3.14	Line Trap shall be mechanically strong enough to withstand the stresses due to maximum wind pressure 260 Kg /m^2	260 Kg /m^2		
4.1	Station class current limiting type Lightning arrestor.	Provided		
4.2	Rated discharge current of lighting arrestor	10 kA (However, co-ordination shall be done by taking 20 kA discharge current into account)		
5.1	Terminal connectors	Provided		
5.2	Terminal connection	Suitable for Twin MOOSE conductor in line side & Twin MOOSE conductor in station side		
5.3	Visual Corona Extinction voltage for clamps and connectors	Not less than 320 kV (rms) (for 400 kV)		
5.4	Radio Interference voltage for clamps and connectors	Not exceed 2500 μV at 266 kV (rms) (for 400 kV)		
5.5	Material of clamp and connector	Non magnetic		
6.0	Bird barriers	Provided		

B) TYPE TESTS

i) Whether all type test reports (as per relevant IS/IEC) of tests conducted earlier on identical or similar material are available (test reports are of the tests conducted not earlier than ten years from 09.02.12) **(YES / NO)**

ii) If type test reports are not acceptable to BHEL/Customer then above tests shall be conducted by the bidder free of cost. **(YES)**

C)

S.No.	Description	Confirmation of Supplier
1.	Bidder to confirm that there are no deviations and the offer is in full compliance with the specification. a) Bidder to confirm that there are no deviations in any other form such as comments, variations and/ or exceptions. b) Bidder to confirm that at all drawings / data sheets/QP/ valid type tests reports/ all relevant information shall be submitted to BHEL for organising approval of ultimate customer.	
2.	Bidder to confirm that it will offer approved Make of the components and fitments at contract stage. In case the offered make is not approved by the customer, then alternate make shall be supplied without any commercial implications to BHEL.	
3.	Qualifying requirements, if any, mentioned in the specification are being met	
4.	a) PGCIL/ NTPC Approved Quality Plan is available for the offered equipment OR b) Standard BHEL Quality Plan to be followed	

Date:

Signature of the authorized representative of Bidder

Company Seal