BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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TITLE				SIGN			
SHIELD WIRE				DATE	07.02.22	-do-	
				GROUP	TBEM	W.O. No	

CUSTOMER	Punatsanchhu Hydroelectric Project Authority-I , Bhutan
CONSULTANT	WAPCOS, Gurugram CEA, New Delhi
PROJECT	Punatsanchhu Hydroelectric Project-I (6X200 MW), Bhutan

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BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP
ENGINEERING MANAGEMENT, NEW DELHI

BHEL Document No.	Rev		Prepared by	Checked by	Approved by
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		Group	TBEM		

Project: BHEL Rate Contract.

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SECTION – I

SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of GI SHIELD WIRE.

The equipment is required for the following project.

Name of the customer : **Punatsangchhu - I Hydroelectric Project Authority (PHPA-I), Bhutan**

Name of the Project : **6x200MW Punatsangchhu - I Hydroelectric Project, Bhutan**

1.1 SPECIFIC TECHNICAL REQUIREMENT

Refer Section II.

1.2 BILL OF QUANTITY

S No.	Description	Unit	Quantity
1	7/9 GI SHIELD WIRE	m	1000

1.3 TESTS

Acceptance and routine test shall be performed by the vendor for each order.

1.4 MANDATORY TYPE TESTS

Bidder shall submit the type test reports of the following type tests-

a) UTS test) As per Clause 2.10.1
b) DC resistance test) As per Clause 2.10.2

SECTION II

STANDARD SPECIFICATION

2.0 GENERAL

This section covers the standard technical specification for GI Shield Wire.

TECHNICAL REQUIREMENTS:

Sl.No	Parameter		
1	Stranding and wire diameter		7/9 SWG
2	Strand Arrangement		7/3.66 mm steel
	Steel core		1
	Outer Steel Layer		6
3	Total sectional area		73.65 mm2
4	Overall diameter		10.98 mm
5	Approximate weight		583 kg/km
6	Calculated d.c. resistance at 200		2.5 ohms/km
7	Minimum ultimate tensile strength		68.4 kN
8	Direction of lay of outer layer		Right hand
9	Standard Drum Length	250/500/1000/2000/4000 meter	
10	Protective coating for storage	Boiled linseed oil to avoid wet storage stains.	

2.1 EQUIPMENT SPECIFICATION

This section covers the general technical requirements of the Galvanised Steel Wire. In case of any discrepancies between the requirements mentioned in this section and those specified in other sections of this specification, this shall prevail after Section 1 and shall be treated as binding requirements.

2.2 APPLICABLE STANDARDS

The Galvanised Steel Wire shall strictly conform to the following Indian and International standards, as appropriate:

IS: 521(1991)	Method for tensile testing of steel wire
ISO/R89-1959	
IS: 1778-1980	Reels and drums for bare conductors
IS: 2629(1990)	Recommended practice for hot dip galvanizing on iron and steel.
IS: 2633(1992)	Method for testing uniformity of coating of zinc-coated articles
IS: 4826(1992)	Hot dip galvanized coatings on round steel wires
ASTMA-475-72a	
IS: 6745 (1990)	Methods for determination of mass of Zinc coating on zinc- coated iron and steel articles

IS: 209(1992) Zinc ingot
IS 398 (Parts-I to V): 1992 Aluminium conductors for Overhead transmission purposes

2.3 TECHNICAL REQUIREMENT AND CONSTRUCTIONAL DETAILS

2.3.1 The galvanized steel stranded wire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part- II):1976 except where otherwise Specified herein.

2.4 WORKMANSHIP

2.4.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

2.4.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

2.4.3 The steel strands shall be hot dip galvanized (and shall have a minimum zinc coating of 275 g/m^2) after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics in ASTM designation B498-74.

2.4.4 The steel strands shall be preformed and post-formed in order to prevent spreading of strands while cutting of composite stranded wire. Care shall be taken to avoid damage to galvanization during pre-forming and post-forming operation.

2.4.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

2.5 JOINTS IN WIRES

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the stranded wire. There shall be no strand joints or strand splices in any length of the completed stranded wire.

2.6 TOLERANCE

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of the individual steel strands and lay length of the stranded wire:

	Standard	Maximum	Minimum
Diameter	3.66mm	3.75mm	3.57mm
Lay length	181mm	198mm	165mm

2.7 MATERIALS

2.7.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and shall conform to the following requirements as to the chemical composition:

Element	% Composition
Carbon	Not more than 0.55
Manganese	0.4 to 0.9
Phosphorous	Not more than 0.04
Sulphur	Not more than 0.04
Silicon	0.15 to 0.35

2.7.2 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity. It shall confirm to and satisfy all the requirements of IS: 209-1979

2.8 STANDARD LENGTH

2.8.1 The stranded wire shall be supplied in standard drum lengths generally in the range of 250/500/1000/2000/4000 m. However, drum lengths where required to be supplied in lengths different from standard lengths specified above shall be provided.

2.9 TESTS

2.9.1 The G.S. Wire should have been type tested as per IEC/IS and shall be subjected to routine and acceptance tests in accordance with applicable IS specifications/ ISO/ ASTMA recommendations. Type test reports of the tests conducted earlier (not more than five years earlier) on similar material shall be submitted. If the valid type test reports are not available with the bidder then the tests shall be conducted by the bidder free of cost.

Equipment/item to be supplied shall conform to type tests as per relevant standards and proven type. The Bidder / Contractor shall furnish the reports of all the type tests carried out in within last **ten years from date of bid opening i.e. 09.02.2012**

2.9.3 TYPE TESTS

In accordance with the stipulation of the specification the following type test reports shall be submitted of the stranded wire.

a) UTS test) As per Clause 2.10.1
b) DC resistance test) As per Clause 2.10.2

2.9.4 ACCEPTANCE TESTS

a) Visual check for joints, scratches etc. and length of stranded wire (As per Clause 2.10.3)
b) Dimensional check(As per Clause 2.10.5)
c) Galvanizing test (As per Clause 2.10.7)
d) Lay length check (As per Clause 2.10.6)

e) Torsion test (As per Clause 2.10.4)
f) Elongation test (As per Clause 2.10.4)
g) Wrap test
h) DC resistance test (IS 398(Part-III))1976
i) Breaking load test (IS 398(Part-III))1976
j) Chemical Analysis of steel (IS 398(Part-III))1976)

2.9.5 ROUTINE TESTS

a) Check that there are no cuts, fins etc. on the strands.
b) Check for correctness of stranding.

2.9.6 TESTS DURING MANUFACTURE

a) Chemical analysis of zinc used for galvanizing (As per Clause 2.10.8)
b) Chemical analysis of steel (As per Clause 2.10.9)

2.9.7 SAMPLE BATCH FOR TYPE TESTING

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance program approved by the Owner. The samples for type testing shall be manufactured strictly in accordance with the quality Assurance Program approved by the Owner.

2.10 TESTING PROCEDURE FOR STRANDED GALVANISED STEEL WIRE

2.10.1 UTS Test

Circles perpendicular to the axis of the stranded wire shall be marked at two places on a sample of stranded wire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 34 kN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 kN and held for one minute. The stranded wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.10.2 D.C Resistance Test

On a stranded wire sample of minimum five metres length, two contact clamps shall be fixed with a pre-determined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C shall conform to the requirements of this specification.

2.10.3 Visual Check for Joints, Scratches etc. and length of Stranded wire

Stranded wire drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and see that the stranded wire generally conforms to the requirements of this specification. The length of stranded wire wound on the drum shall be measured with the help of counter meter during rewinding.

2.10.4 Torsion and Elongation Tests

The test procedures shall be as per relevant clause of IS 398 (Part V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 64% for a gauge length of 200 mm.

2.10.5 Dimensional Check

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

2.10.6 Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this specification.

2.10.7 Galvanizing Test

The test procedure shall be as specified in IS: 4826-1968. The material shall conform to the requirements of this specification.

2.10.8 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

2.10.9 Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

2.11 Following drawings/ documents shall be submitted for approval/ information for each project:

i) Guaranteed and other technical particulars
ii) Drum Drawing
iii) Type, Acceptance, sample and routine test reports

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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-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

		(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	:	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 ± 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. 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, 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/m^2 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.

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:

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.

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.

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 – IV

GUARANTEED AND TECHNICAL PARTICULARS OF STRANDED G. S.WIRE

S. No.	Description	Unit	Particulars
1.	**Name & Address of manufacturer**		
2.	**Particulars of raw materials**		
2.1	Aluminium		
	a) Minimum Purity of Aluminium	%	
	b) Maximum Copper Content	%	
2.2	Steel wires/Rods		
	a) Carbon	%	
	b) Manganese	%	
	c) Phosphorous	%	
	d) Sulphur	%	
	e) Silicon	%	
2.3	Zinc		
	a) Minimum purity of Zinc	%	
3.	**STEEL STRANDS BEFORE STRANDING**		
3.1	Diameter		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
3.2	Minimum breaking load of strand	kN	
3.3	Maximum Resistance of 1 M Length of strand of 20°C	Ohm	
4.0	**STEEL STRANDS AFTER STRANDING**		
4.1	a) Nominal Diameter	mm	
	b) Maximum Diameter	mm	
	c) Minimum Diameter	mm	
4.2	Minimum breaking load of strand	kN	
4.3	Galvanising		
	a) Min. weight of zinc coating of uncoated wire surface	g/ m^2	
	b) Min. number of one minute dips that the galvanised strand can withstand in the standard Preece test	Nos.	
	c) Min. No. of twists in gauge length equal to 100 times the dia of wire which the strand can withstand in the torsion test	Nos.	
5.	**COMPLETED STRANDED WIRE**		
5.1	UTS of stranded wire	kN	
5.2	Lay length of outer steel layer	mm	
5.3	DC resistance of stranded wire at 20°C	Ω/km	
5.4	Direction of lay of outer layer	-	
5.5	Linear mass of earth wire		
	a) Nominal	Kg/km	
	b) Maximum	Kg/km	
	c) Minimum	Kg/km	
6.0	Is drum as per I.S	Yes/No	
5.6	Standard length of stranded wire in the drum	m	

ANNEXURE – A

NO DEVIATION CERTIFICATE

It is confirmed that there is no deviation and the offer is in full compliance with the specification. It is also confirmed that there are no deviations in any other form such as comments, variations and or exceptions. Further it is confirmed that at all drawings/ data sheets/ QP/ type tests reports shall be submitted to BHEL for organizing approval of ultimate customer. Also, furnishing of all relevant information/ repetition of type tests (if required for meeting the specification requirement) shall be carried out by us at no extra cost to BHEL and without affecting delivery requirements.

Signature of the authorized representative of Bidder

Name _____

Designation _____

Place _____

Date _____

Company Seal

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-316-365-SW	Rev. No.	00		Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	SB	DKS	VK
TITLE SHIELD WIRE				SIGN			
				DATE	07.02.22	-do-	7.2.22.
				GROUP	TBEM	W.O. No	

CUSTOMER	Punatsanchhu Hydroelectric Project Authority-II , Bhutan
CONSULTANT	WAPCOS, Gurugram CEA, New Delhi
PROJECT	Punatsanchhu Hydroelectric Project-I (6X170 MW), Bhutan

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BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP
ENGINEERING MANAGEMENT, NEW DELHI

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Title Shield Wire		Date	07.03.14	07.03.14	07.03.14
		Group	TBEM		

Project: BHEL Rate Contract.

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SECTION – I

SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of GI SHIELD WIRE.

The equipment is required for the following project.

Name of the customer : **Punatsangchhu - II Hydroelectric Project Authority (PHPA-II), Bhutan**

Name of the Project : **6x200MW Punatsangchhu - II Hydroelectric Project, Bhutan**

1.1 SPECIFIC TECHNICAL REQUIREMENT

Refer Section II.

1.2 BILL OF QUANTITY

S No.	Description	Unit	Quantity
1	7/9 GI SHIELD WIRE	m	1400

1.3 TESTS

Acceptance and routine test shall be performed by the vendor for each order.

1.4 MANDATORY TYPE TESTS

Bidder shall submit the type test reports of the following type tests-

a) UTS test) As per Clause 2.10.1
b) DC resistance test) As per Clause 2.10.2

SECTION II

STANDARD SPECIFICATION

2.0 GENERAL

This section covers the standard technical specification for GI Shield Wire.

TECHNICAL REQUIREMENTS:

Sl.No	Parameter		
1	Stranding and wire diameter		7/9 SWG
2	Strand Arrangement		7/3.66 mm steel
	Steel core		1
	Outer Steel Layer		6
3	Total sectional area		73.65 mm2
4	Overall diameter		10.98 mm
5	Approximate weight		583 kg/km
6	Calculated d.c. resistance at 200		2.5 ohms/km
7	Minimum ultimate tensile strength		68.4 kN
8	Direction of lay of outer layer		Right hand
9	Standard Drum Length	250/500/1000/2000/4000 meter	
10	Protective coating for storage	Boiled linseed oil to avoid wet storage stains.	

2.1 EQUIPMENT SPECIFICATION

This section covers the general technical requirements of the Galvanised Steel Wire. In case of any discrepancies between the requirements mentioned in this section and those specified in other sections of this specification, this shall prevail after Section 1 and shall be treated as binding requirements.

2.2 APPLICABLE STANDARDS

The Galvanised Steel Wire shall strictly conform to the following Indian and International standards, as appropriate:

IS: 521(1991)	Method for tensile testing of steel wire
ISO/R89-1959	
IS: 1778-1980	Reels and drums for bare conductors
IS: 2629(1990)	Recommended practice for hot dip galvanizing on iron and steel.
IS: 2633(1992)	Method for testing uniformity of coating of zinc-coated articles
IS: 4826(1992)	Hot dip galvanized coatings on round steel wires
ASTMA-475-72a	
IS: 6745 (1990)	Methods for determination of mass of Zinc coating on zinc- coated iron and steel articles

IS: 209(1992) Zinc ingot
IS 398 (Parts-I to V): 1992 Aluminium conductors for Overhead transmission purposes

2.3 TECHNICAL REQUIREMENT AND CONSTRUCTIONAL DETAILS

2.3.1 The galvanized steel stranded wire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part- II):1976 except where otherwise Specified herein.

2.4 WORKMANSHIP

2.4.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

2.4.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

2.4.3 The steel strands shall be hot dip galvanized (and shall have a minimum zinc coating of 275 g/m^2) after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics in ASTM designation B498-74.

2.4.4 The steel strands shall be preformed and post-formed in order to prevent spreading of strands while cutting of composite stranded wire. Care shall be taken to avoid damage to galvanization during pre-forming and post-forming operation.

2.4.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

2.5 JOINTS IN WIRES

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the stranded wire. There shall be no strand joints or strand splices in any length of the completed stranded wire.

2.6 TOLERANCE

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of the individual steel strands and lay length of the stranded wire:

	Standard	Maximum	Minimum
Diameter	3.66mm	3.75mm	3.57mm
Lay length	181mm	198mm	165mm

2.7 MATERIALS

2.7.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and shall conform to the following requirements as to the chemical composition:

Element	% Composition
Carbon	Not more than 0.55
Manganese	0.4 to 0.9
Phosphorous	Not more than 0.04
Sulphur	Not more than 0.04
Silicon	0.15 to 0.35

2.7.2 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity. It shall confirm to and satisfy all the requirements of IS: 209-1979

2.8 STANDARD LENGTH

2.8.1 The stranded wire shall be supplied in standard drum lengths generally in the range of 250/500/1000/2000/4000 m. However, drum lengths where required to be supplied in lengths different from standard lengths specified above shall be provided.

2.9 TESTS

2.9.1 The G.S. Wire should have been type tested as per IEC/IS and shall be subjected to routine and acceptance tests in accordance with applicable IS specifications/ ISO/ ASTMA recommendations. Type test reports of the tests conducted earlier (not more than five years earlier) on similar material shall be submitted. If the valid type test reports are not available with the bidder then the tests shall be conducted by the bidder free of cost.

Equipment/item to be supplied shall conform to type tests as per relevant standards and proven type. The Bidder / Contractor shall furnish the reports of all the type tests carried out in within last **ten years from date of bid opening i.e. 09.02.2012**

2.9.3 TYPE TESTS

In accordance with the stipulation of the specification the following type test reports shall be submitted of the stranded wire.

a) UTS test) As per Clause 2.10.1
b) DC resistance test) As per Clause 2.10.2

2.9.4 ACCEPTANCE TESTS

a) Visual check for joints, scratches etc. and length of stranded wire (As per Clause 2.10.3)
b) Dimensional check(As per Clause 2.10.5)
c) Galvanizing test (As per Clause 2.10.7)
d) Lay length check (As per Clause 2.10.6)

e) Torsion test (As per Clause 2.10.4)
f) Elongation test (As per Clause 2.10.4)
g) Wrap test
h) DC resistance test (IS 398(Part-III))1976
i) Breaking load test (IS 398(Part-III))1976
j) Chemical Analysis of steel (IS 398(Part-III))1976)

2.9.5 ROUTINE TESTS

a) Check that there are no cuts, fins etc. on the strands.
b) Check for correctness of stranding.

2.9.6 TESTS DURING MANUFACTURE

a) Chemical analysis of zinc used for galvanizing (As per Clause 2.10.8)
b) Chemical analysis of steel (As per Clause 2.10.9)

2.9.7 SAMPLE BATCH FOR TYPE TESTING

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance program approved by the Owner. The samples for type testing shall be manufactured strictly in accordance with the quality Assurance Program approved by the Owner.

2.10 TESTING PROCEDURE FOR STRANDED GALVANISED STEEL WIRE

2.10.1 UTS Test

Circles perpendicular to the axis of the stranded wire shall be marked at two places on a sample of stranded wire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 34 kN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 kN and held for one minute. The stranded wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.10.2 D.C Resistance Test

On a stranded wire sample of minimum five metres length, two contact clamps shall be fixed with a pre-determined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C shall conform to the requirements of this specification.

2.10.3 Visual Check for Joints, Scratches etc. and length of Stranded wire

Stranded wire drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and see that the stranded wire generally conforms to the requirements of this specification. The length of stranded wire wound on the drum shall be measured with the help of counter meter during rewinding.

2.10.4 Torsion and Elongation Tests

The test procedures shall be as per relevant clause of IS 398 (Part V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 64% for a gauge length of 200 mm.

2.10.5 Dimensional Check

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

2.10.6 Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this specification.

2.10.7 Galvanizing Test

The test procedure shall be as specified in IS: 4826-1968. The material shall conform to the requirements of this specification.

2.10.8 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

2.10.9 Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

2.11 Following drawings/ documents shall be submitted for approval/ information for each project:

i) Guaranteed and other technical particulars
ii) Drum Drawing
iii) Type, Acceptance, sample and routine test reports

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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-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

		(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	:	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 ± 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. 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, 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/m^2 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.

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:

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.

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.

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 – IV

GUARANTEED AND TECHNICAL PARTICULARS OF STRANDED G. S.WIRE

S. No.	Description	Unit	Particulars
1.	**Name & Address of manufacturer**		
2.	**Particulars of raw materials**		
2.1	Aluminium		
	a) Minimum Purity of Aluminium	%	
	b) Maximum Copper Content	%	
2.2	Steel wires/Rods		
	a) Carbon	%	
	b) Manganese	%	
	c) Phosphorous	%	
	d) Sulphur	%	
	e) Silicon	%	
2.3	Zinc		
	a) Minimum purity of Zinc	%	
3.	**STEEL STRANDS BEFORE STRANDING**		
3.1	Diameter		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
3.2	Minimum breaking load of strand	kN	
3.3	Maximum Resistance of 1 M Length of strand of 20°C	Ohm	
4.0	**STEEL STRANDS AFTER STRANDING**		
4.1	a) Nominal Diameter	mm	
	b) Maximum Diameter	mm	
	c) Minimum Diameter	mm	
4.2	Minimum breaking load of strand	kN	
4.3	Galvanising		
	a) Min. weight of zinc coating of uncoated wire surface	g/ m^2	
	b) Min. number of one minute dips that the galvanised strand can withstand in the standard Preece test	Nos.	
	c) Min. No. of twists in gauge length equal to 100 times the dia of wire which the strand can withstand in the torsion test	Nos.	
5.	**COMPLETED STRANDED WIRE**		
5.1	UTS of stranded wire	kN	
5.2	Lay length of outer steel layer	mm	
5.3	DC resistance of stranded wire at 20°C	Ω/km	
5.4	Direction of lay of outer layer	-	
5.5	Linear mass of earth wire		
	a) Nominal	Kg/km	
	b) Maximum	Kg/km	
	c) Minimum	Kg/km	
6.0	Is drum as per I.S	Yes/No	
5.6	Standard length of stranded wire in the drum	m	

ANNEXURE – A

NO DEVIATION CERTIFICATE

It is confirmed that there is no deviation and the offer is in full compliance with the specification. It is also confirmed that there are no deviations in any other form such as comments, variations and or exceptions. Further it is confirmed that at all drawings/ data sheets/ QP/ type tests reports shall be submitted to BHEL for organizing approval of ultimate customer. Also, furnishing of all relevant information/ repetition of type tests (if required for meeting the specification requirement) shall be carried out by us at no extra cost to BHEL and without affecting delivery requirements.

Signature of the authorized representative of Bidder

Name _____

Designation _____

Place _____

Date _____

Company Seal

ANNEXURE-TQR

TECHNICAL PRE- QUALIFICATION REQUIREMENT

Name of customer: PHPA-1 & 2

Name of Project: 6X200 MW PUNATSANGCHHU-I HEP & 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN

Name of Item: 7/9 GI SHIELD WIRE

PI No: **PI Date:**

PQR Sr. No	PQR Description	Supporting Document to be attached
1.	The Bidder should have supplied GI Shield wire during the last 10 years from the date of Bid opening.	a) Copy of Purchase Orders / LR / MDCC / DI

Prepared By:	Checked By:	Approved By:
Soumik Banerjee	Dileep Kumar Shukla	Vivek Kapil
(Mgr-TBEM)	(Sr.Manager-TBEM)	(Sr DGM - TBEM.)