



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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BHEL Document No. TB 356 316 001		Rev. 01	Name	Prepared by AK	Checked by DKM	Approved by RS
Type of Document	Technical Specification		Sign	-sd-	-sd-	-sd-
Title	420 kV ISOLATORS/ EARTH SWITCH		Date	24.07.13	30.07.13	30.07.13
			Group	TBEM		
			W.O. No			
CUSTOMER		PHPA - I/ PHPA - II, Bhutan				
CONSULTANT	WAPCOS Ltd, Gurgaon					
	Central Electricity Authority, New Delhi					
PROJECT	1. 6X200 MW PUNATSANGCHHU-I HEP, BHUTAN					
	2. 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN					
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01	01.05.15	AK	<i>[Signature]</i>	AS	Revised based on clarifications received from customer.	
Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS	
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SECTION -1

Scope, Specific Technical Requirements and Quantities

1.1 SCOPE

This specification covers requirements of design, manufacture, assembly and testing at the Manufacturer's premises/ works and packing and supply of **400kV Isolators for Punatsangchhu-I & Punatsangchhu-II** projects, complete in all respects and including all fittings and accessories required for efficient and trouble-free operation.

No deviation from the requirements specified in various clauses of this specification shall be allowed. A certificate to this effect shall have to be furnished along with the offer as per attached annexure. In case this annexure is not submitted, it shall be presumed that the equipment/ material to be supplied under this contract shall be in compliance with the requirements of this specification.

1.2 TERMINOLOGY

The following terminology shall be applicable for the purpose of interpreting the relevant clauses of this Specification.

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

1.3 TYPE TESTS

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

A. Isolators and Earthing Switches (As per IS 1818 /IEC 129)

- Lightning Impulse voltage test (As per IEC clause 6.1.6.1. This test shall be performed only on isolator)
- Switching Impulse voltage test
- Power frequency voltage withstand test
- Radio Interference voltage (RIV) & corona tests
- Temperature rise test
- Measurement of resistance of main circuits (for Isolators)
- Tests to prove the capability of carrying the peak short circuit current and rated short time current
- Tests to prove the short circuit making performance of earthing switches
- Mechanical endurance tests
- Seismic withstand test on Isolator mounted on Support Structure

B. Operating mechanism boxes

- Dielectric tests according to IEC 60439.1



b) Verification of degree of protection IP55 as per IEC 60529

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

1.4 ERECTION COMMISSIONING AND TESTING

The offer shall be deemed to include Bidder's supervision in erection, commissioning and testing of equipment of each type. However if there persistent problems of alignment of subsequent switches, the bidder's assistance shall be deemed to be included in the offer for the subsequent erection also until full satisfaction of the Owner without any extra charge.

1.5 SPECIFIC TECHNICAL REQUIREMENTS

420 kV, 50 kA for 1.0 sec, 3-ph, mechanically gang operated Horizontal Double break, upright mounted, isolators with two earth switches as mentioned under technical requirements below shall be supplied. **The Isolators and Earthing Switches shall be equipped with motor operating mechanism for normal operation and with a manual operating mechanism for emergency use**

1.6 TECHNICAL PARAMETERS

SN	Technical Particulars	Details
1	Rated voltage kV (rms)	420
2	Type	Outdoor, Horizontal Double Break
3	Operating mechanism of Isolator	Motorized (Both Local & Remote) and Emergency Manual
4	Operating mechanism of earth switch	Motorized (Both Local & Remote) and Emergency Manual
5	Rated frequency (Hz)	50 Hz (+3%, -5%)
6	No. of poles	3
7	Design ambient Temperature (°C)	40
8	Rated insulation levels	
9	Full wave lightning impulse withstand voltage (1.2/50 micro sec.)	
	- between line terminals and ground	± 1425 kVp
	- between phases	$\pm 1425 + 240$ kVp
10	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	
	- between line terminals and ground	± 1050 kVp
	- between terminals with isolator open	$\pm 900 + 345$ kVp
11	One minute power frequency dry and wet withstand voltage	
	- between line terminals and ground	520 kV rms
	- between terminals with isolator open	610 kV rms
12	Corona extinction voltage (kV rms) with isolator in all positions	320 (min)
13	Max. radio interference Voltage (micro-volts) for Frequency between 0.5 MHz and 2 MHz in open &	1000



	close position at 266 kV _{rms}	
14	Minimum creepage distance	10500
15	Phase to phase spacing (mm)	7000
16	Max. continuous current rating of Isolators (Amp.)	2000 A
17	Rated short time Current for 1 sec	50 kA
18	Rated peak short circuit Current	125 kAp
19	Maximum Capacitive current which can be safely interrupted by the Isolator	As per IEC
20	Maximum temperature rise above ambient temperature at rated current of : - Contacts - Hottest part	within limits as per table 4 of IEC
21	Interlocks with circuit breakers	Bolt interlock electrically operated
22	Rating of auxiliary contacts	220 V DC for control and interlock; 415V AC, 3 phase for motor drive
23	Breaking capacity of auxiliary contacts	2 A DC with circuit Time constant of not less than 20 ms
24	Rated mechanical Terminal load	As per table III of IEC 129 (1984) or 50 Kg whichever is higher
25	Insulator Data (Not in bidder's scope) Type Number of units Height of stack Cantilever strength - Upright	(To be solid core type only) Solid core Porcelain type 3 3650mm 600 Kg
26	Min. No. of auxiliary contacts On each isolator	Besides requirement of this spec. The bidder shall wire Up 10 NO +10 NC+ 2 MBB (NO+NC) to TBs for purchaser's future use
27	Min. No. of auxiliary contacts On each earthing switch	Besides requirement of this spec. The bidder shall wire Up 8 NO +8 NC to TBs for purchaser 's future use
28	Interlocking coil provided for each Isolator	Yes
29	Interlocking coil provided for each Earth Switch	Yes
30	DC fail annunciation contact	Yes
31	AC fail/ motor fail annunciation contact	Yes
32	Spare way for local/ remote switch for SCADA	Yes
33	Operating time	12 sec. or less
34	Number of terminals in Control cabinet (Inter-pole Cabling shall be supplied By the supplier)	All contacts and control circuits are to be wired upto control cabinet (plus 20 % spare terminals exclusively for employer's use). Spare TBs are required in the Master pole for terminating all the NO & NC contacts of the Follower poles.
35	Whether type tests carried out on similar isolators (Yes/ No)	If yes, type test reports shall be furnished. If not, tests shall be conducted at no extra cost.
36	Whether all routine / tests as per latest standards will be carried out on each isolator (Yes/ No)	Yes. All routine/ acceptance tests shall be conducted in presence of the purchaser's representative.

1.7 BILL OF QUANTITIES

Section-1



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

Technical Specification
Section-1: Scope, Specific Technical Requirements and Quantities

Doc No: TB-356-316-001
Rev. No. 01

S.N.	DESCRIPTION	QUANTITY	
		PHPA-1	PHPA-2
Main Items			
1	400kV, 2000A, 3-pole mechanically ganged and motor operated Horizontal Double Break Isolator with mechanically ganged & motor operated Earth switches on both sides complete with all accessories but without post insulator, terminal connectors and support structure.	4 No.	6 No.
2	Lump sum supervision charges for erection, testing and commissioning of one no. Isolator with special tools and test instruments in Bidder scope	1 No.#	1 No.#
Spares			
4	Main & auxiliary contactors for Isolators & Earth Switches	1 Set*	1 Set*
5	Switches for Isolators & Earth Switches	1 Set*	1 Set*

Note: -

1. '#' – Supervision charges shall be quoted on **lump sum** basis only. Bidder shall estimate required no. of mandays for supervision based on his own experience & shall submit a checklist for input wrt site readiness. It will be the sole responsibility of the bidder to obtain site readiness checklist before deputing any of his personnel at site
2. '*' – 1 set shall be adequate for 1 set (3 pole) of Isolator with earth switches.
3. The scope of supply includes hardware and accessories but excludes solid core insulators, structures for mounting the isolators and terminal connectors. The corona rings (if required) are included in scope of supply.



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EQUIPMENT SPECIFICATION

2.1 GENERAL

This section covers the general technical requirements of Isolator. 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 TECHNICAL REQUIREMENT OF EQUIPMENT

The manufacturer whose Isolators are offered, should have designed, manufactured, tested as per IEC/IS or equivalent standard and supplied the isolator for the specified system voltage and fault level

All exposed ferrous parts shall be hot dip galvanised as per IS 2633 & 4579 or relevant IEC.

All current making and breaking contact surfaces shall be silver plated. The silver plating shall preferably be not less than 25 microns in thickness.

The requirement regarding protection from external corona and RIV as specified for equipment shall include the fittings. The corona rings wherever used shall preferably be of non-magnetic materials.

The equipment name plate / wiring diagram plate should preferably be of stainless steel. In case of aluminium, it should be at least 2 mm thick. The inscription on the name plate/wiring diagram plate shall be engraved and no punching shall be accepted except for equipment Sl. No. and year of manufacture. These shall be provided with information as per normal practice including name of manufacturer, type of equipment, rated voltage etc.

2.3 APPLICABLE STANDARDS

The Isolator shall conform to the following Indian / International standards:

Three phase induction motors	: IS:325 - 1978
Alternating current disconnectors and earthing switches	: IS:9921- 1985
Alternating current disconnectors and earthing switches	: IEC:62271-102 (2001-12)
AC Disconnectors and Earthing switches	: IEC – 129
AC Disconnectors for Line Charging Current Switching	: IEC – 1128
AC Earthing Switches for induced Current Switching	: IEC – 1129
High Voltage Switches	: IEC-60265
Common Specification for High Voltage Switchgear and controlgear	: IEC60694
Degree of protection provided by enclosures for LV Switchgear and Control gear	: IS – 2147
Schedule of preferred ratings, Manufacturing Specification and Application Guide for High Voltage Air Switches, Bus Supports and Switch accessories	: ANSI-C37.32



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Test Code for high voltage air switches Power switching equipment	: ANSI-C37.34 : NEMA-SG6
Method for testing uniformity of coating of zinc coated articles.	: IS:2633- 1986
Recommended practice for hotdip galvanizing on iron & steel	: IS:2629 - 1985
Hot dip Zinc coating on structural steel and other other allied products.	: IS:4759 - 1984
Electric power connectors	: IS:5561- 1970
Method for determination of mass of zinc coating on iron and steel articles.	: IS:6745- 1972
Low voltage switchgear and Controlgear General rules (Part 1)	: IS:13947- 1993
Dimension for steel plates, sheets, strips and flats for gen engg purposes	: IS:1730- 1989
Dimension for wrought Al and Al alloy sheet & strip	: IS:2676- 1981

2.4 TYPE & RATING

The Isolators shall be of three phase, gang operated double break horizontal type, installed in outdoor Pothead Yard. These Isolators shall be provided with the Earthing Switches on both sides and shall conform to IEC-129. The rating and other technical particulars of these isolators shall be as under:

a)	Type	Horizontal double break group operated type Isolators
b)	Installation	Out door
c)	Normal system voltage	400 kV
d)	Highest system voltage	420 kV
e)	Frequency	50 Hz (-5% to + 3%)
f)	No. of poles	3
g)	Rated current	2000A
h)	Rated short time current for 1 sec.	50 kA
i)	One minute power frequency withstand voltage	610 kV _{rms}
j)	Lightening Impulse withstand voltage	1425 kV _{peak}
k)	Rated switching impulse withstand voltage	1050 kV _{peak}
l)	Total operating time of isolator	<12 secs.



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- | | | |
|----|---|-------------------------|
| m) | Rated capacitive current make and break capacity | 0.5 Amps. |
| n) | Partial discharge level | ≤ 10 pico coulomb |
| o) | Corona extinction voltage | 320kV _{rms} |
| p) | Radio interference voltage at 266 kV _{rms} | $\leq 2,500$ microvolts |

2.5 DESIGN AND CONSTRUCTIONAL FEATURES

2.5.1 General

- 2.5.1.1 The Isolators and Earthing Switches shall be equipped with motor operating mechanism for normal operation and with a manual operating mechanism for emergency use. The motor shall be protected by MCCBs / contactors / starters etc.
- 2.5.1.2 The opening and closing of the Isolators and Earthing Switches shall be possible from local as well as from remote (Control Room). The local and remote control of the Isolators and Earthing Switches shall be obtained by means of selector switches.
- 2.5.1.3 The Isolators and Earthing Switches shall be designed for normal current rating as specified and shall be capable of withstanding the electrical and mechanical stresses induced corresponding to specified fault level.
- 2.5.1.4 The Isolators and Earthing Switches shall have mechanical position indicators on the local control cabinets located in Pothead Yard control room and remotely in the Power House Control Room. The details of the inscriptions & coloring for the indicators are given as under:
- | | Sign | Back ground colour |
|-----------------|-------------|---------------------------|
| Open position | Open | Green |
| Closed position | Closed | Red |
- 2.5.1.5 The Isolators and Earthing Switches including their operating mechanism should be of robust design such that their open or closed positions may not change by gravity, wind pressure & due to vibrations generated by short circuit & earth quake shocks. The operating mechanism should be easy to operate by a single person and conveniently located for local operation in the Pothead Yard.
- 2.5.1.6 The temperature rise of contacts and other current carrying parts shall not be more than the specified temperature rise as per latest issue of IS:1818 or IEC equivalent standard. The temperature rise due to the passage of the rated short circuit current for a period of 3 seconds shall not cause any annealing or welding of the contacts.
- 2.5.1.7 Live metal parts except insulator caps and base shall be of non-rusting & non-corroding metal. Current carrying parts shall be of non-ferrous material. Screws and pins shall be provided with lock washers or equivalent facility.
- 2.5.1.8 All cabinets having operating mechanisms shall have illumination lamp fittings & 3 pin sockets of 5A with toggle switches and heaters of adequate ratings with thermostats.
- 2.5.1.9 The design shall be such that changes in mounting and connection can be made at site without excessive labour and with minimum replacement of parts.
- 2.5.1.10 Factory adjustment shall be so made that field adjustments will not be required on the isolators and earth switch. When interphase connections are attached to the rotating insulator in the field all phases shall make and break simultaneously.



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- 2.5.1.11 Isolator & earth switches shall be complete with rigid bases and shall be supplied with suitable channels, nuts and bolts for mounting on steel structure.
- 2.5.1.12 The disconnect switch shall have padlocking arrangement in both 'open' and 'close' position.
- 2.5.1.13 Bolts, nuts, pins, etc. shall be provided with appropriate locking arrangement such as lock nuts, spring washers, key etc.

2.5.2 Type and Duty Requirements

- 2.5.2.1 The disconnect switches shall be horizontal double break type.
- 2.5.2.2 The disconnect switch shall carry rated current continuously and short time current for 1 second.
- 2.5.2.3 In addition, the disconnect switch shall be capable of making and breaking
 - a) Magnetizing current of the voltage transformer.
 - b) Capacitive current of the buses and short connections.
- 2.5.2.4 Isolators and earth switches shall be capable of withstanding the dynamic and thermic effects of the maximum short circuit current of the system in their closed position.
- 2.5.2.5 Isolators shall be suitable to break the capacitive charging currents during their opening. The contact shielding shall also be designed to prevent re-strikes and high local stresses caused by the transient recovery voltages when these currents are interrupted.
- 2.5.2.6 The earth switches wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism
- 2.5.2.7 In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The inter-locking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in Section 3.
- 2.5.2.8 The earthing switches shall be capable of discharging trapped charges of the associated Lines.
- 2.5.2.9 The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminal of each pole of the isolators on account of make/break operation.
- 2.5.2.10 The isolator shall be capable of making and breaking magnetizing/capacitive currents of 0.7A at 0.15 power factor.
- 2.5.2.11 Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.

2.5.3 Isolators

- 2.5.3.1 The operating devices of Isolator shall be arranged in such a way that all the three phases shall operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage till the motor overload protection operates.



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- 2.5.3.2 It shall be possible to operate the Isolators manually by cranks or hand wheels. The manual operating mechanisms shall be complete with all necessary fittings.
- 2.5.3.3 The operation of the Isolators shall be interlocked electrically with the associated circuit breakers in such a way that the Isolator control is inoperative if the circuit breaker is closed. Additional electromagnetic type interlock shall also be provided on the manual operating handle and control cubicle for motorised operation so as to prevent the operation of the Isolator manually or electrically when the circuit breaker is closed.
- 2.5.3.4 The Isolators shall be supplied with 10 normally open & 10 normally closed contacts of auxiliary switches for use by others over and above those required in the control circuits of the Isolator. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.
- 2.5.3.5 The signaling of the closed position of the Isolators shall not take place unless it is certain that the movable contacts have reached a position in which the rated normal current, peak withstand current and short-time withstand current will be carried safely.
- 2.5.3.6 The signaling of the open position of the Isolators shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.
- 2.5.3.7 The auxiliary switches shall be capable of breaking at least 2 A in a 220-V DC circuit with a time constant of not less than 20 milliseconds.
- 2.5.3.8 All electrical sequence interlocks will apply in both remote and local control modes.
- 2.5.3.9 Isolators shall have heavy duty self-aligning high pressure type fixed contacts made of hard drawn electrolytic copper being of modern design. The various parts should accordingly be finished to ensure interchangeability of similar components. These contacts shall have liberal dimensions so as to withstand safely the highest short circuit current and over voltage that may be encountered during the service. The surfaces of the contacts shall be rendered smooth. The male and female contact assemblies shall be of such construction and design that these shall ensure:
- Electrodynamics withstandability during short circuit.
 - Thermal withstandability during short circuit
 - Constant contact pressure even if the live parts of the insulator stacks are subjected to tensile stress due to linear expansion of connected bus bar or flexible conductors either because of temperature variations or strong wind.
 - Wiping action during opening and closing.
 - Self alignment during closing of the switch without minute adjustment.
- 2.5.3.10 The main contacts shall be of **silver plated copper alloy** and controlled by powerful springs designed for floating and pressure point contact.
- 2.5.3.11 The contacts having sufficient area and pressure for carrying rated continuous and short time current without excessive heating liable to cause pitting and welding.
- 2.5.3.12 Contacts shall be adjustable to allow for wear, shall be easily replaceable and shall have minimum movable parts and adjustments.
- 2.5.3.13 No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary through out the life of the isolator or earth switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.



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- 2.5.3.14 The surface of the moving & fixed contacts shall be smooth and silver plated having a thickness of not less than 25microns.
- 2.5.3.15 Arcing horns shall be provided to divert the arc from main contacts to the separating horns after the main contacts have opened. Arcing horns shall be renewable type.
- 2.5.3.16 The fixed contact isolators shall be provided with springs which ensure that there is always a positive contact with adequate pressure to give enough contact surfaces for passage of current. The springs provided shall not go out of alignment or get entangled with the moving contact during operation. The springs provided shall be of non ageing type and its strength shall not reduce appreciably during the life span of the isolator. Contact spring shall not carry any current and shall not loose their characteristic due to heating effect.

2.5.4 Blades

The switch blade shall be so assembled that no part of the blade can move relative to the other. Bending and torsional stress shall not exceed $1/3^{rd}$ of the rated strength of the insulator unit. All movable parts which may be in current path shall be shunted by flexible copper conductors. The conductor shall have sufficient length to prevent breaking.

All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent.

The bolts, pins or springs used in current carrying parts shall also be of stainless steel. All castings and hardware other than those in the current carrying parts shall be of malleable cast iron, hot dip galvanised/electro galvanised, as appropriate.

The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where applicable. Where this is impracticable, adequate corona shields shall be provided. Corona shields/rings etc. shall be made of aluminium/aluminium alloy.
The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected.

The switch shall be designed such that lubrication of any part is not required except at very long intervals. i.e. after every 1000 operations or after 5 years whichever is earlier.

2.5.7 Earthing Switches

- 2.5.7.1 The Earthing Switches shall match with the main Isolator in quality and be capable of withstanding the electrical and mechanical stresses induced by the currents corresponding to fault current of Isolators.
- 2.5.7.2 The main grounding connections on each Earthing Switch shall be rated to carry the full short circuit current for 3 secs. Each earth switch shall be provided with flexible copper braids for connection to ground mat. These braids shall have the same short time current carrying capacity as the earth blades. The transfer of fault current through swivel connection will not be accepted.
- 2.5.7.3 The isolators shall be equipped with earthing switches and these shall form an integral part of the isolator and shall be mounted on the base frame of the isolator
- 2.5.7.4 The earthing switches shall have complete operating mechanism and auxiliary contacts.
- 2.5.7.5 The operating mechanism for the earthing switches shall be motor as well as manual operated.
- 2.5.7.6 Earthing switch shall be triple pole, for 3-pole disconnect switch, with provision for padlocking in both open and close positions.



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- 2.5.7.7 Each Earthing Switch shall consist of three earthing links mechanically coupled to an operating shaft suitable for manual operation and shall normally rest on the frame. The blades of the Earthing Switches shall open or close in vertical plane.
- 2.5.7.8 Each Safety Earthing Switch shall be electrically interlocked with its associated Isolator and Circuit Breaker such that it can only be closed if both the Circuit Breaker and Isolator are open.
- 2.5.7.9 Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will automatically render inoperative the electrical control circuits.
- 2.5.7.10 Each Earthing Switch shall be fitted with 8 normally open and 8 normally closed auxiliary switches for use by others over and above those required for local interlocking and position indication.
- 2.5.7.11 Provision shall be made for padlocking the Earthing Switches in the open & closed positions.
- 2.5.7.12 All auxiliary switches and interlocking coils shall be wired up to terminal blocks in mechanism box through G.I. conduits.
- 2.5.7.13 The earthing switches shall consist of three earthing links which shall normally reset against the frames when the connected isolator is in the closed position.
- 2.5.7.14 The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.
- 2.5.7.15 It should be possible to interchange position of earth switch to either side of the pole at site without disturbing constructional interlock.
- 2.5.7.16 The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to earth mat.
- 2.5.7.17 The earthing switches shall also comply with the requirement of IEC-1129, 1992 in respect of induced current switching duty as defined for Class B earthing switches.

2.5.8 Bearings

The design and construction of the various bearings shall have all the features required to withstand the specified climatic conditions so as to ensure dependable and effective operation even after long period of inaction of these isolators and switches. All bearings in the current paths shall be shunted by flexible copper conductors of adequate cross section. Bearing housing shall be sturdy and weather proof. All bearings shall be filled & sealed with first filling of lubricants which shall be long lasting in nature. Facilities shall be provided for lubrication of bearings if not sealed for life and if washers do not have facility of greasing.

2.5.9 Operating Mechanism and Control

- 2.5.9.1 The isolators and Earthing Switches shall be motor operated from local as well as from remote. The local/remote selector switch with various indicators shall be installed in local control cubicle.
- 2.5.9.2 The motor operating mechanism suitable for operation with **3 phase 415 volts or 1 phase 240 volts A. C. supply** shall be provided to facilitate remote control of Isolators and shall comprise of a motor, starter, necessary control gear, unit switches and position indicators etc. To ensure safety, the motor operated mechanism shall automatically be rendered inoperative by interrupting supply when the manual operating mechanism is in use. The motor operating mechanism shall be mounted on the steel frame of support structure of the Isolator at a suitable level and shall be enclosed in a weather proof & vermin proof steel enclosure.



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- 2.5.9.3 Each rotating stack of isolator shall have double roller or double ball bearings at both ends. The roller & ball bearing shall be adjustable and accessible for dismantling. The bearing housings shall be weather-proof and self lubricating type.
- 2.5.9.4 The vertical operating shaft shall be supported on ball or roller guide bearings. The guide bearing shall be designed for mounting on the base supported column at a convenient working distance above the ground.
- 2.5.9.5 The entire design of the operating mechanism shall be such that minimum energy will be required for the operation of the Isolator. The blades shall be counter balanced to prevent them from falling and getting closed from any position in the event of failure of any link of the operating mechanism.
- 2.5.9.6 A flexible copper conductor shall be provided for connecting the vertical operating shaft at the lower end to the ground bus.
- 2.5.9.7 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of other poles. The play in the linkages shall not be excessive. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/pipes shall be provided with suitable universal couplings to account for any angular misalignment.
- 2.5.9.8 All isolator and earth switches shall be provided with manual operating handles enabling one man to open or close the isolator with ease in one movement only while standing on ground level. The operating handle shall be provided with pad locking arrangement and located at around 1 meter from the base of isolator support structure.
- 2.5.9.9 All rotating parts including rotating insulator shall be supported on double roller or ball bearings. These shall be protected from the weather by means of covers and grease retainers. Bearing pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.
- 2.5.9.10 All isolators and earth switches shall be provided with operating handles and double hinged doors with padlocking arrangement for the operating mechanism box.
- 2.5.9.11 A flexible conductor of adequate size shall be provided for connecting the vertical operating shaft at the lower end to the station ground bus.
- 2.5.9.12 Control Cabinets shall be of **Aluminium or Mild sheet Steel as specified in Section 3, clause 12.9** and shall be dust, water and vermin proof. Unless otherwise specified, thickness of sheet used shall be at least **3 mm**. for aluminium and properly braced to prevent wobbling.
- 2.5.9.13 The enclosure of the control cabinets shall provide a degree of protection of not less than **IP 55** as per IS: 13947(Part 1).
- 2.5.9.14 All doors, removable covers and plates shall be gasketed all around with good quality neoprene gaskets.
- 2.5.9.15 Cable entry shall be from the bottom. Suitable removable cable gland plate shall be provided on the cabinet for the purpose. Cable glands shall be of double compression type, made of brass and supplied loose. Cable sizes and No. of cable glands will be indicated at the contract drawing approval stage.
- 2.5.9.16 In case of motorised isolator, suitable space heaters shall be mounted in the cabinet to prevent condensation. Heater shall be suitable for 240V, 50 Hz, single phase A.C. supply.



SECTION: 2

- 2.5.9.17 The terminal blocks to be provided shall be of either **ELMEX OR PHOENIX** make.(refer clause no. 12.7 of section-3 for details).
- 2.5.9.18 For looping the auxiliary power supply cable, suitable terminals should be provided, for 6/10 sq.mm cables. These terminals are to be separated from the others and fitted with transparent plastic covers and shall have warning labels with red lettering.
- 2.5.9.19 The terminal shall be staggered that the connection of external cable to terminal block should be possible without disturbing the rest of the connections. The terminal block arrangements shall be such as to provide maximum accessibility to all conductor terminations and any arrangement preventing ready access to other terminal screws shall not be accepted.
- 2.5.9.20 The arrangements shall be such that it is possible so safely connect or disconnect terminals and replace fuse links on live circuits.
- 2.5.9.21 A "Local/Remote" selector switch and a set of open/close push buttons shall be provided on the control cabinet of the isolator and earth switch to permit its operation through local or remote push buttons.
- 2.5.9.22 Provisions shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.
- 2.5.9.23 Easy access shall be provided for all components on which adjustment or tightening is expected to be done at site, without removal of other components.
- 2.5.9.24 Counter balance springs shall be provided for counter balancing the isolators to prevent impact at the end of travel both on opening and closing of the isolator. The spring shall be made of non rusting type alloy.
- 2.5.9.25 The fixed contact and its tensioning by spring shall be such that there will be a positive contact with adequate pressure to give enough contact surface for passing the current. The springs provided shall not go out of alignment or get with the moving contact during operation. The springs provided shall be of non - ageing antirust type and its strength shall not reduce appreciably during life span of isolator.

2.5.9 Motor operated mechanism

- 2.5.9.1 The motor shall satisfy the requirements specified in IS: 325.
- 2.5.9.2 The scheme shall be so designed that during manual operation the motor drive shall be automatically electrically de-coupled.
- 2.5.9.3 Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. A quick electro mechanical brake shall be fitted on the higher speed shaft.
- 2.5.9.4 Limit switches for motor control shall be fitted on the isolator shaft within the cabinet to sense the open and close positions of the isolator. The switches shall be snap type and shall have adequate number of NO/NC contacts for use in the indication scheme. The switches shall be adjusted in a manner so that moving contacts reach their final open and close position with proper alignment.

2.5.10 Auxiliary Switch

- 2.5.10.1 All auxiliary switch contacts shall be wired to a suitable terminal board fixed on the support structure. **At least 6 spare terminals** shall be provided in the board for any future control wiring. The contacts of all auxiliary switches shall be strong enough and it shall be possible to convert 'Normally Open' into 'Normally Closed' contacts and vice-versa with minor modifications.



SECTION: 2

- 2.5.10.2 The breaking capacity of the auxiliary contacts shall be adequate for the current to be controlled.
- 2.5.10.3 The contacts shall be convertible type so that normally open contact may be converted to normally closed contact and vice-versa at site.
- 2.5.10.4 The auxiliary contacts shall be rated 10A at 240V A.C. and 2A at 220V D.C.
- 2.5.10.5 The auxiliary contacts shall be adjustable type to suit the following requirement:-
- Signaling of 'Close position' shall not take place unless the main power contacts have reached a position so that rated normal and short time current can be carried safely
 - Signaling of 'Open position' shall not take place unless the main power contacts are at a safe isolating distance.
- 2.5.10.6 Auxiliary switches which are installed on the frame of isolators or earthing switches shall be suitably protected against accidental arcing from the main circuit.
- 2.5.10.7 Auxiliary switches shall be mounted in a weather proof housing which shall have provision for entry of conduits of proper sizes, or for fixing of cable glands.
- 2.5.10.8 Auxiliary switches which are installed on the frame of the isolators or earthing switches shall be suitably protected against accidental arcing of the main contact.
- 2.5.10.9 The breaking capacity of the auxiliary switches shall be adequate for the circuit to be controlled.
- 2.5.10.10 The contacts shall be capable of breaking at least 2 Amp in a 230V D.C circuit with a time constant of not less than 20 milliseconds.
- 2.5.10.11 Fixing hardware on the auxiliary contacts shall not cause hindrance to the movement of the contact fingers.
- 2.5.10.12 Auxiliary Contacts shall be capable of being set such that:
- Signaling of the closed position shall not take place unless the contact system has reached such a position that the rated normal and rated short time current can be carried safely.
 - Signaling of the open position shall not take place unless the contact system has reached such a position of at least 80 percent of the isolating distance.
 - A simultaneous signaling device for all poles of an isolator shall be arranged in such a way that the signal is given only when all poles of the isolator have a position in accordance with (a) and (b) above.

2.5.11 Base

Each single pole of the isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure. The base shall be rigid and self supporting and shall require no guying or cross bracing between phases other than the supporting structures.

The position of movable contact system (main blades) of each of the isolators and earthing switches shall be indicated by a mechanical position indicator. The indicator shall be of metal and shall be visible from operating level.

2.5.12 Safety Interlocking



SECTION: 2

2.5.12.1 The Isolators and Earthing Switches shall be provided with the interlocking features as specified below :

- i) All mechanical interlocks shall be designed to prevent mal-operation when hand power is applied.
- ii) All electrical interlocks shall function in such a way that they interrupt the operating supply when it is in hand-operating mode.
- iii) The failure of supply to any electrical interlock shall not permit faulty operation.
- iv) The interlocking gear shall operate satisfactorily between 85% to 110% of rated auxiliary supply voltage.
- v) Each Isolator shall be electrically interlocked to prevent the Isolator being operated on load.
- vi) It shall be possible to close the Earthing Switch only when the Isolating Switch is in fully open position.
- vii) It shall be possible to close the Isolating Switch only when the Earthing Switch is in fully open position.

2.5.12.2 In addition to above, the contractor shall provide without extra charges, further mechanical and / or electrical interlocks required by the purchaser for safe operation of the equipment.

2.5.12.3 A separate key shall be provided for making the whole interlocking scheme in-operative when desired.

2.5.12.4 The supplier shall supply interlocking gear box for ease of interlocking wiring. This box shall be free standing outdoor weather proof type and shall have rows of terminal connectors suitable for receiving 2.5 sq. mm multicore control cables.

2.5.12.5 All isolators and isolator-cum-earthing switches shall be suitable for electrical interlocking. In addition to the provision of electrical interlocking, the Isolator and the earthing switch shall also be interlocked through the castle key electro-mechanical interlock. Mechanical interlocks, if applicable, shall be so designed that force cannot be transmitted to points remote from the point at which hand force is applied.

2.5.12.6 The earth switches wherever provided shall be mechanically and electrically interlocked so that they can be operated only when the isolator is open and vice-versa.

2.5.12.7 In addition to the interlock between isolator and its earth switch, they shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. The interlocking arrangement shall be such that operation is prevented even if interlocking conditions change at any stage during electrical or manual operation of isolator. All these interlocks shall be of the 'failsafe' type and shall be suitable for continuous operation from DC supply between 80% and 110% of the rated voltage i.e. 220 volts.

2.5.13 Padlocks

2.5.13.1 Padlocks or other approved locking arrangement shall be provided for locking each Isolator and Earthing Switch operating handle in both the ON and OFF positions with the operating motor automatically disengaged and for locking each cover or door in the closed position. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key.

2.5.13.2 All padlocks shall be of approved size and two ordinary keys for each type of padlock shall be provided. Master key for the same is not permitted.

2.4.13 Control Wiring (refer clause no. 12.7 & 12.7 of section-3 for details)



SECTION: 2

All the control and secondary circuits and auxiliary contacts of the isolator shall be wired completely and up to the terminal blocks in the operating mechanism box.

The control wiring shall be of adequate cross-section and not less than 2.5mm^2 copper.

All wires shall have PVC insulation for 1100 Volts and shall be suitable for switch board wiring. At least 20 per cent terminals with a minimum of 24 Nos. as spare for future use shall be provided over and above the numbers required, in the MOM box.

2.4.15 Grounding

Each disconnect switch operating rod shall be separately grounded at a point above the mechanism box.

This shall be done by flexible copper braid of adequate section but in no case less than 70mm^2 .

Electro-galvanised hardware may be used only where the hot dip galvanised hardware is not available in the required sizes. Generally, all steel hardware above M10 size should be hot dip galvanised. Hardware should be of GKW or equivalent make. If any other make is used, the same shall be subject to purchaser's approval.

2.4.16 Assembly

The Disconnect switch along with its base frame and operating mechanism shall be completely assembled and checked for correct alignment and operation at manufacturer's works prior to dispatch.

2.5 TESTS

Details of tests to be performed for isolator, earthing switches & mechanism boxes shall be as per **clause no. 1.3 of section-1** of this specification.

The test shall be performed on one fully equipped unit and shall utilize the maximum supply voltage on the control and motor circuit. The test shall clearly demonstrate that the motor supply MCBs / MCCBs will operate before any deformation of the mechanism linkages or switch parts has taken place. In all cases the main switch and its auxiliary switches shall remain in their correct relative positions at all times.

ii) Routine tests (As per IS-1818)

- a) Power frequency dry withstand voltage test of the main and auxiliary contacts
- b) High voltage tests on auxiliary and control circuits
- c) Tests to prove satisfactory operation as per IS 1818
- d) Measurement of resistance of main & auxiliary contacts
- e) Mechanical operating test



SECTION - 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

GENERAL TECHNICAL REQUIREMENTS

1.0 PROJECT LOCATIONS

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

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

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

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

2.0 PROJECT DETAILS

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



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

Technical Specification

Doc No: TB-356-316-0XX

Section-3: Project Details & General Specifications

Rev. No. 00

	(Generation) Punatsangchhu-I Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)- 02-376135	(Generation) Punatsangchhu-II Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)-02-376135
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2.1 SITE CONDITIONS (FOR DESIGN PURPOSES)

2.1.1 SITE CONDITIONS

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

2.1.2 DESIGN AMBIENT

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

2.1.3 RELATIVE HUMIDITY

a). Maximum :: 100%

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

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

2.1.5 SEISMIC FACTORS

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



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

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

2.1.6 COMMUNICATION & TRANSPORT LIMITATIONS

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

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

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

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

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

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

2.1.7 AUXILIARY POWER SUPPLY

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



2.1.8 SYSTEM PARAMETERS

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

2.1.9 MINIMUM CLEARANCE

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

3 INSTRUCTION TO BIDDERS

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

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification. It is recognised that the Manufacturer may have standardised on the use of certain components, materials, processes or procedures different than those specified herein

4 STANDARDS

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

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

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable



standards, which shall form an integral part of the specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

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

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

5 MATERIALS

5.1 General Requirements for materials

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

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

5.2 Corrosion Resistant Materials

5.2.1 Bronze hinge pins shall be provided for all doors.

5.2.2 The surface of mild steel fabricated items and other metal surfaces shall be thoroughly cleaned by grit blasting and coated with corrosion resisting paint to prevent rusting. The Bolts or Nuts, which are subject to frequent removal and the bolts to be projected



above the concrete with nuts subjected to removal, shall either be of stainless steel or hot dip galvanized / electro galvanized.

5.3 Magnetic & Non-magnetic materials

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

6 DESIGN STRESSES

6.1 General Criteria

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

7 WORKMANSHIP

7.1 General Requirements

- 7.1.1 Workmanship shall be of the highest grade and in accordance with the best modern practices for the manufacture of high-grade machinery, notwithstanding any omissions from these specifications or associated drawings. All work shall be performed by workmen skilled in their respective trades.
- 7.1.2 Machining of renewable parts shall be accurate and to specify dimensions according to the drawing so that replacements made may be readily installed. The Supplier shall keep and maintain in storage for at least 10 years or more, at his own expense, sufficient templates, gauges, patterns, or other records used in the manufacture to enable him to make repair and furnish replacement parts for future needs. Notwithstanding this, if the Manufacturer/Bidder, in future, intends to wind up his business, he shall give the information to this effect to the Purchaser, sufficiently in advance, so as to enable him to consider buying life time spares before the closure of



the business.

8 STRUCTURAL MATERIALS

8.1 Bolts, Nuts, Studs and Screwed Connections

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

8.2 Fastening Elements for Equipment

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

8.3 Galvanizing

- (i) All drilling, punching, tapping, cutting, and bending of various parts shall be completed and all burrs removed prior to galvanizing.
- (ii) Galvanizing shall be applied by the hot dipped process and shall consist of the smooth, clean zinc coating free from defects and of uniform thickness. The quantity



of Zinc applied shall not be less than 610g/m² of the surface area. Original blast-furnace raw-zinc (minimum purity 98%) shall be used. Sheardizing or other alternative process shall not be used without the approval of the Purchaser and / or Consultant.

- (iii) Material / parts on which galvanizing has been damaged shall be redipped unless, in the opinion of the purchaser, the damage is local and can be repaired by applying a coat of galvanizing repair paint.

8.4 Non-metallic Coatings

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

8.5 Material of Rating Plates, Name Plates and Labels

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

8.6 Machine Work

- 8.7.1 Unless otherwise shown on the approved shop drawings, all allowances, tolerances, and gauges for metal fits shall conform to applicable ISS or to ANSI Standard B4.1 for the class as shown or otherwise required. Sufficient machining allowance shall be left while placing pads to ensure true surface of solid material. Finished contact or bearing surfaces shall be true and exact to ensure full contact.
- 8.7.2 All machined parts shall be accurately machined and like parts shall be interchangeable. Drilled holes for bolts shall be accurately located and drilled to templates when necessary or specified. The holes for fit-up bolts or dowels shall be carefully reamed and the bolt or dowel shall enter with a light driving fit. Bolt and



screw threads shall conform to applicable ISS or to ISO standard.

8.8. Surface Finish

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

8.9 Type of Finish and Roughness Value

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

8.10 Unfinished Surfaces

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

10 PAINTING AND PROTECTIVE COATINGS

10.1 General Requirements

- (a) All surfaces shall be thoroughly cleaned of rust, mill scale, oil, grease and dirt prior to shipment and before painting. Paint shall only be applied to dry and clean surfaces.
- (b) Except for surfaces that will be embedded in concrete and as otherwise specified, all un-machined or unturned internal or external surfaces shall be given not less than one coat of red lead primer. Any exterior surfaces



requiring welding during manufacture shall be ground smooth after welding before application of the primer coat. The primer coat shall be applied quickly after the welding and grinding is over.

- (c) Except as otherwise provided the Bidder's standard painting system for miscellaneous auxiliary equipment such as motors, motor starters, gauges, pumps, etc. will be satisfactory. All equipment shall have a neat & attractive appearance.
- (d) Flaws in exterior surfaces shall be ground smooth before applying the prime coat. This shall in no way reduce the unit strength.
- (e) The minimum total dry film thickness shall be **1.5 mils (38 microns)** for prime finishes 2 mils (50 microns) for lacquer finishes and 3 mils (75 microns) for enamel finishes.
- (f) All needs of final touch up paint for application at site shall be included in the scope of supply.

10.2 Specific Requirements

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

10.3 Conforming Standards for Paints

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

11 CASTING

11.1 General Requirements

Castings shall be free from injurious defects and foundry irregularities such as projections, ridges, hollows and chip marks so that they will not require surface smoothing operations in the field prior to painting. The location of existing defects shall be determined and they shall be completely removed to



sound metal. The structure of the castings shall be homogenous and free from excessive non-metallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting shall not be permissible and such casting shall be rejected. All castings involving welded fabrication shall be stress-relieved.

11.2 Dimensions of Castings

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

11.3 Surface Finish

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

12 ELECTRICAL EQUIPMENT – GENERAL REQUIREMENTS

12.1 Electric Motors

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



- 12.1.7 The terminal box shall be weatherproof and firmly fixed to the motor frame. The terminal studs shall be adequately sized for the current duty required and shall be identified. All terminal boxes shall have approved cable adapter plates, sealing chambers or conduit entries.
- 12.1.8 The arrangement of the terminal box shall be such as to facilitate installation of cables and allow interchanging of any two phase leads without disturbing the sealing compound, if this is used at cable terminations.
- 12.1.9 Wherever practicable, the motor end cover shall be removable from the driving end and shall have a removable plug to allow the speed to be checked by means of a portable tachometer.
- 12.1.10 All motors having a mass of 50 kg or more shall be fitted with lifting lugs.

12.2 Starters and Contactors

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

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

12.3.1 MCCBs

All moulded case circuit breakers shall be 2-pole or 3-pole, as required, having



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

12.3.2 MCBs

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

12.4 Control Relays

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

12.5 Pilot Devices

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

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

12.6 Instruments / Meters

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

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

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

12.6.4 The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale.

12.6.5 The instruments which make contacts shall have contacts suitable for 250 V AC or



220 V DC circuits.

- 12.6.6 All the instruments shall conform to relevant National or International applicable standards. They shall be subjected to type and routine tests prior to despatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V to ground (RMS) for one (1) minute as per the relevant standards.
- 12.6.7 The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at the rated voltage of the instrument. The coil rating of the measuring instruments shall be co-ordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade as far as accuracy class is concerned.

12.7 Terminal Blocks

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

- | | | |
|----|-----------------------|---|
| a) | All circuit except CT | Min. two (2) Nos. 2.5sq.mm.
Copper flexible. |
|----|-----------------------|---|



- b) All CT circuits Min. of 4 nos. of 4.0mm²
copper Flexible

12.7.6 There shall be a minimum clearance of **250 mm** between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks shall be minimum of **150 mm**.

12.7.7 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Cabinet wiring should be suitable for 50 deg. C as the space heaters will keep the temperature 10 deg. C higher than the ambient.

12.7.8 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal is run parallel and in close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite to the wiring duct shall be reserved for the external cable connection. All adjacent terminal blocks shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cables.

12.8 Equipment Wiring

12.8.1 Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilizing slip-on ferrules approved by the purchaser.

12.8.2 The markers provided may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

12.8.3 The markers must withstand a tropical environment and high humidity. Only fungus-proof materials will be accepted. The ferrules of adhesive type are not acceptable.

12.8.4 All trip circuits shall employ markers having a red background.

12.8.5 Sensitive control circuits shall be effectively shielded against extraneous signals and interference. Separate terminals shall be provided for termination of individual cable shields which will be grounded at source end only.

12.8.6 All wiring connections shall be readily accessible and removable for test or other purposes. The wiring between the terminals of the various devices shall be point to point.

12.8.7 The splices or tee connections between terminal points are not acceptable. The wire runs shall be neatly trunked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipment.

12.8.8 **Multi-conductor copper cables 2.5 sq.mm for PT circuits and 4.0 sq.mm for CT circuits** shall be connected to the terminal blocks in such a manner as to minimise crossovers. The claw washers or crimp type connectors used shall be of approved design & shall be used to terminate all small wiring. The grommets or insulating bushings shall be installed, where necessary.



12.9 Cubicles and Control Panels

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



- 12.9.12 All the cubicles and the control panels shall be provided with lamacoid name plates, non-rustic, identifying the purpose of the panel & all its components.

12.10 Alarm Contacts

- 12.10.1 Wherever applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices:

- (i) Local annunciator
- (ii) Station annunciator
- (iii) Computerized Control System.

- 12.10.2 All alarm contacts shall be of changeover type. Wherever required, relays shall be provided as contact multiplier.

12.11 Earthing

- 12.11.1 The earthing terminals for the equipment covered in these specifications shall also be included in the scope of supply. The supplier shall connect the earthing terminals to the grounding conductors available in the vicinity area of the equipment.

- 12.11.2 The earthing risers from the station earthing mat to the vicinity of equipment will be arranged by the purchaser unless specified otherwise.

13 QUALITY ASSURANCE PLAN (QAP)

3.1 Quality Assurance Programme

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

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

13.2 Quality Assurance Test

- 13.3.1 A quality assurance plan detailing specific control procedures proposed to be adopted for controlling the quality characteristics for major items & equipment shall be furnished. The bidder shall submit and finalise manufacturing Quality Plans for all the major components and equipment with the purchaser. These quality plans will detail out various tests/inspections to be carried out and standards as mentioned in these specifications, various quality practices & procedures followed by bidder's Quality Control Organisation, the relevant reference documents acceptance norms etc., various stages of material procurement, manufacture, assembly and final testing/performance testing etc. These shall include but not limited to the following:

- (i) Test of raw material.
- (ii) Non Destructive Tests as approved by Purchaser.



- (iii) Component Inspection and Tests.
- (iv) Assembly Inspection and Tests.
- (v) Pressure Test
- (vi) High Voltage Dielectric and other test
- (vii) Operational Tests
- (viii) Performance and efficiency tests as applicable.

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

14 DEVIATIONS FROM SPECIFICATIONS

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

15 PACKING AND FORWARDING

- 15.1 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The bidder shall be responsible for any damages to the equipment during transit, due to improper and inadequate packing. The easily



damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by bidder without any extra cost. The replacement of damaged equipment shall be made promptly in order to complete the work within specified schedule and without waiting for the settlement of insurance claim.

15.2 The outside of the Box shall have the following details:

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

A copy of detailed packing list shall also be kept inside the Box.

15.3 All removable external accessories and other components susceptible to damage if transported mounted on the equipment, shall be dismantled, adequately packed and shipped separately. All openings thus resulted shall be sealed by means of temporary steel plates (blanks).

15.4 Packing shall be sturdy and adequate to protect all assemblies, components, auxiliary devices and accessories from injury by corrosion, dampness, heavy rains, breakage and vibration encountered at the plant site.

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

16 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

16.1 All the equipment, apparatus, materials and supplies covered under the specification shall be subjected to test in the shop and at the field In the presence of the representatives of PHPA / consultants/ BHEL for conformity with the requirements of the specifications. The method and procedure for the tests shall be as specified for particular item or shall be in conformity with the applicable standards for making such tests. The details of the test procedures and test equipment to be used should be intimated well in advance i.e. at least 6 weeks before these tests are conducted.

16.2 The end customer (PHPA)/ BHEL, his duly authorised representative and/or outside inspection agency acting on behalf of purchaser shall have at all reasonable times access to the supplier's premises or works and shall have the power to inspect and examine the materials and workmanship of the works during its manufacture or erection. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The equipment, if found unsatisfactory at any stage as to workmanship or material is liable to be rejected.



- 16.3 The test reports shall indicate the tests performed, the results obtained, instruments used, names of personnel carrying out the tests and provision for signature of the witnesses. They shall also show the test report number and the date of conducting the test. The format of these reports shall be submitted alongwith testing procedures for the Purchaser's (PHPA)/ BHEL approval well in advance.
- 16.4 All services such as labour, materials, electricity, fuel, water, stores, apparatus and instruments required for conducting any or all tests shall be arranged & provided by the supplier at his cost.

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

17 TRANSPORTATION, HANDLING, STORING AND INSTALLATION

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

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

Where assemblies are supplied in more than one section, bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses. Bidder shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms

18 DOCUMENTATION

18.1 DRAWINGS

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

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

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



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

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

18.2 DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A	For Approval (7 Sets – each revision), Hard copies as well as soft copies
07	Copies of GA drawings with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
07	Copies of type test reports
07	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.
07	Copies of manufacturing and field quality plan.
07	Copies of installation, operation & Maintenance manual.
B	After Approval and For Information/Distribution (5 Sets).
05	Copies of GA drawings
05	Copies of type, Routine & Acceptances manual.
05	Copies of Insulation, Operation & Maintenance manual.
05	Set's of 'As Built' drawings
01	Sets of RTF of all drawings
02	All drawing/documents AS BUILT on CD-ROM.

NOTE:

- Any revision of drawings / documents shall be submitted in the same no. of copies submitted first time for approval
- 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 FOR ISOLATORS AND ISOLATOR-CUM-EARTHING SWITCHES

S. No.	Particulars	Unit	400kV System
A	Isolator with Grounding Switches		
1.	Manufacturer's Name and address		
2.	Type		
3.	Standard to which conforms		
4.	Rated voltage		
5.	Rated current		
6.	Maximum permissible current		
7.	Rated frequency		
8.	1.2/50 micro second lightening impulse withstand test voltage - Between line terminals and ground - Between phases		
9.	Flashover voltage of Isolator's arcing horns with 1.2/50 μ secs. impulse wave against ground		
10.	250/2500 μ second switching impulse withstand test voltage - Between line terminals and ground - Between terminals in open position		
11.	Dry & wet one minute power frequency withstand test voltage - Between line terminals and ground - Between terminals in open position		
12.	Maximum continuous current rating of Isolators		
13.	Rated short time current for: - 1 second - 3 seconds		
14.	Rated peak short circuit current		
15.	Maximum capacitive current which can be safely interrupted by the Isolator		
16.	Maximum Inductive current of the line that can be safely interrupted by the Isolator		
17.	Fault current which can be withstood by an earth switch - Rated peak short circuit current of earthing switch - 1 minute power frequency withstand test voltage of ES * Between terminal to ground * Across open contacts - 1.2/50 μ second lightening impulse withstand test voltage for ES - 250/2500 μ second switching impulse withstand test voltage for ES		
18.	TRV caused by breaking / making capacitive current		
19.	TRV caused by breaking / making inductive current		
20.	Maximum temperature rise above ambient temperature at rated current of : - Contacts - Hottest part		



SECTION IV

21.	Type of Isolator operating mechanism		
22.	Whether separate operating mechanism provided for operation of main blades and earthing blades		
23.	Current during closing of Isolators		
24.	Current during opening of Isolators		
25.	Closing time - Main blades - Earthing blades		
26.	Opening time - Main blades - Earthing blades		
27.	Operating voltage range		
28.	Rating of motor		
29.	Torque required to: - Open the Isolator - Close the Isolator		
30.	Design data of main contacts - Material of contacts - Type - Contact area - Contact pressure - Thickness of contact surface - Contact surface treatment by * Silver coating * Electrolytic plating - Overall distance for making of contacts - Distance between contacts in fully open position - Current density at minimum cross section of switch blade - Speed of break of contacts		
31.	Partial discharge level		
32.	Corona extinction voltage		
33.	Radio interference voltage level		
34.	Auxiliary switches of Isolators - No. of NO and NC contacts - Rated voltage - Rated current - Test Voltage - No. of operations the switch can withstand without any need for inspection - No. of operations which the switch can withstand without deteriorating the contacts		
35.	Mounting of Isolator - Type - No. of poles per phase - No. of breaks per phase		
36.	Safety factor accounted for designing the Isolator		
37.	Type and material used for arcing contacts, if provided		
38.	Weight of 3 pole Isolator with ground- ing switches on both sides		
39.	Type of interlock proposed between main isolator and grounding switch		
40.	Rated supply voltage of operating devices and auxiliary		



SECTION IV

	circuits		
41.	Whether type test reports for Isolators & earthing switches enclosed		
42.	Rated mechanical terminal load		
43.	Location, type and number of bearings		
44.	Clearance in air (minimum) - Between phases - Between live parts and earth		
45.	Distance between centers of outer stacks of insulators		
46.	Distance between fixed contacts and the blade in open position		
47.	Test to be conducted by the manufacturer at works - Type tests - Routine tests		
48.	Tests to be conducted at site		
49.	Details of insulators - Make - Type - Size - Weight - Cantilever Strength - No. of Units per stack - Diameter of Shell - Height of stack - Creepage distance - Dry arcing distance - 1 minute dry & wet withstand voltage - Power frequency flashover voltage - Impulse withstand voltage - Impulse flashover voltage - Hissing voltage - Puncture Voltage		
50.	Whether type test reports for insulators enclosed		
51.	Type and material of connectors		
52.	Shipping weights & dimensions of largest & heaviest packages		
53.	Drawings and other information documents enclosed		
54.	Details and weight of supporting structure		

CONTROL CABINETS

1	Manufacturer's Name		
2	Indoor/Outdoor application		
3	Design ambient air temp (° C)		
4	Standards applicable		
5	Thickness of sheet steel (mm) and whether cold rolled or hot rolled		
6	Degree of protection provided		



SECTION IV

7	Bill of material for all the equipment mounted on control cabinet giving the following details: Make and type Applicable Standard Voltage rating Current rating Duty class, if applicable Manufacturer's Catalogue No		
8	Total heat load of cabinet (for purpose of ventilation requirement)		
9	Colour of finish paint IS : 5 Outside Inside		
10	Control Wiring		
	Size of Conductor		
	i) for CT circuits		
	ii) for other circuits		
	Conductor Solid/Stranded		
	Number of Strands / conductor		
11	Terminal Blocks		
	Make & type		
	Current rating		
	i) Power terminals (A)		
	ii) Other terminals (A)		
12	Space Heater Rating at 240 V AC		
13	Control cabinet drawing showing the following		
	Outline dimensions floor openings floor/ wall/pedestal fixing arrangements weights etc.		
	Front view, inside view showing the mounting arrangement of various equipment		
13	Schematic/wiring diagram of control cabinet enclosed		
14	Interconnection drawing showing Owner's external cable, connections to the control cabinet enclosed		
15	Type test report to verify degree of protection enclosed.		
16	Details of terminal rows :		
	Whether arranged vertical or horizontal		
	Clearance from adjacent components		
	Distance between rows		
	Whether transparent protection cover provided		



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

Technical Specification
Section-4: Guaranteed Technical Particulars

Doc No: TB-356-316-001
Rev. No. 01

SECTION IV



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

Technical Specification
Section-5: Quality Plan

Doc No: TB-356-316-001
Rev. No. 01

SECTION – 5

QUALITY PLAN

Bidder shall follow standard BHEL Quality Plan.



(INFORMATION TO BE FURNISHED WITH OFFER)

BIDDERS ARE INSTRUCTED TO WRITE 'YES' UNDER CLOUMN '2', IF THE INFORMATION / SCHEDULE IS FURNISHED / ENCLOSED WITH THE OFFER, **OR** WRITE 'NO' UNDER CLOUMN '2', IF THE INFORMATION / SCHEDULE IS NOT FURNISHED / ENCLOSED WITH THE OFFER, **OR** WRITE 'NOT APPLICABLE (NA)' UNDER CLOUMN '2', IF THE INFORMATION / QUERY / SCHEDULE IS NOT RELEVANT TO THEM, **AND**

RETURN THIS CHECKLIST AS THE PART OF THE OFFER DULY SIGNED BY THEM.

ISOLATORS / GROUNDING SWITCHES		400kV Isolators	
S.No.		Specified Requirement	Confirmation Yes/No
1.	Rated Voltage (KV)	420	
2.	Type of Isolator	Outdoor, HDB	
3.	Standard applicable for isolators and earthing switches	IEC:62271-102 (2001-12), IS:9921- 1985	
4.	Rated Current Under site conditions (A) at 50° C ambient-	2000	
5.	Rated short time withstand Current	50kA for 1 sec	
6.	Rated frequency (Hz)	50	
7.	Number of poles	Three	
8.	Phase to phase spacing (mm)	7000	
9.	Whether all 3 poles are ganged	Mechanically	
10.	Opening time of isolator and earth switch (Sec.)	Less than 12	
11.	Closing time of isolator (Sec.)	Less than 12	
12.	Temperature rise over 50° C ambient temperature corresponding to maximum continuous current (°C)	As per table V of IEC-694	
13.	Seismic Acceleration (Horizontal & vertical)	0.4 g & 0.2g	
14.	Dielectric withstand capacity of completely assembled isolator/isolator and earth switch		
14.1	One minute dry power freq. Withstand test voltage(KV rms)		
	i. against ground (KV rms)	520	
	ii. Across isolating distance (KV rms.)	610	
14.2	1.2/50 micro's impulse withstand test voltage		
	i. Against ground (KVP)	±1425	
	ii. Across isolating distance (KVP) -	±1425+240	
14.3	250/2500 micro sec. switching surge withstand test voltage (dry & wet)		
	i. Against ground (KVP) -	±1050/NA	
	ii. Across isolating distance (KVP)	±900+345/NA	



ISOLATORS / GROUNDING SWITCHES		400kV Isolators	
S.No.		Specified Requirement	Confirmation Yes/No
15.	Corona extinction voltage (KV rms) –	320	
16.	Max. radio interference Voltage (micro-volts) for Frequency between 0.5 MHz and 2 MHz in open & close position at 266 kV _{rms}	1000	
17.	Total creepage distance to ground (mm)	10500	
18.	Operating Mechanism for Isolator	Motor, Mech ganged	
19.	Operating Mechanism for Earth Switches	Motor, Mech ganged	
20.	Whether constructional Mechanical interlock between Isolator & Earth switch provided	YES	
21.	Whether interlock between Isolator & Earth switch provided	Mechanical/ Electrical/ Both	
22.	Arrangement provided to prevent electrical or manual operation unless interlock conditions are satisfied	YES	
23.	Rated Mechanical Terminal Load	As per Table -3 of IEC-62271-102	
24.	Whether interlock coil is continuously rated	YES	
25.	Rated DC control voltage and variation allowed	220V	
26.	Material of contacts	silver plated copper	
27.	Thickness of silver plating of contacts	25 micron	
28.	Material of Current carrying parts	High conductivity electrolytic copper/ Aluminium	
29.	Number of auxiliary contacts on isolator/pole for Owner's use	10 NO+ 10 NC +2 MBB	
30.	Number of auxiliary contacts on earth switch/pole for Owner's use	8NO + 8 NC	
31.	Rating of Auxiliary contacts	10 A at 220V DC	
32.	Rated DC breaking current of Auxiliary contacts with 20 ms time constant (A)	2 A	
34.	Height from mounting plane to top of terminal stud	8000	
35.	All valid Type test reports(as per clause no. 1.3A, section-1) not older than 10 years, available	Yes, available	
36.	If the valid type test reports are not available with the bidder then the following tests shall be conducted by the bidder free of cost		
CONTROL CABINETS			
37.	Application	Outdoor	
38.	Material of control cabinet sheet	Aluminium sheet steel	
39.	Thickness of sheet (mm)		



ISOLATORS / GROUNDING SWITCHES		400kV Isolators	
S.No.		Specified Requirement	Confirmation Yes/No
	Aluminium Sheet steel (Hot rolled) Sheet steel (Cold rolled)	3mm	
40.	Degree of protection provided	IP55	
41.	Standard applicable for control cabinet	IS-5093/IS-8623, IEC-439	
42.	Whether Hot Dip Galvanised	YES/No	
43.	Size of Conductor used in Control Wiring of control cabinet	4 & 2.5 sq.mm	
44.	20 % Spare Terminal Blocks provided in control cabinet	YES	
45.	Confirm to follow the BHEL/Customer SMQP	Confirmed	
46.	All valid Type test reports(as per clause no. 1.3B, section-1) not older than 10 years, available	Yes, available	
47.	If the valid type test reports are not available with the bidder then the following tests shall be conducted by the bidder free of cost		
48.	Following accessories not limited to this is included or not:		
A	Hardware for Structure (BHEL supply) to Base Channel (vendor supply)*	YES	
B	Hardware for Base Channel (vendor supply) to Bottom of Post Insulator (BHEL supply)	NO	
C	Hardware for Top BPI (BHEL supply) to Male/Female Member	YES	
D	Hardware for Structure (BHEL supply) to MOM Box	YES	
E	Hardware for Structure (BHEL supply) to Earth Switch MOM	YES	
F	Terminal Connectors	NO	
G	Support Insulators	NO	
H	Support Structure	NO	

* – length of bolts shall be decided on the basis of 12mm thickness of top plate of mounting structure.

Date:

Place:

(Signature of the authorized representative of Bidder / Firm / Company)

Phone:

Name:

Fax:

Designation:

E-mail:

Company Seal:

Mobile:

Website: