Section I - Common Technical Requirements

1.1 General

In the following sections, this document describes equipment required for the tender. The common technical specifications are to mainly state the general requirements commonly applied for all the Packages. If there is any discrepancy in the requirements between the General Specifications and the Technical Specifications in this Section, the requirements mentioned in Technical Specifications shall prevail.

1.2 Scope of Work

The supply contract includes the design, manufacture, testing, insurance, delivery in complete form (assembly at warehouse if required) unloading and proper handing over the supplies to the Purchaser's Warehouse at Phuentsholing/Pasakha, Bhutan, of the Equipment as specified in the Price Schedule.

All necessary foundation bolts, rag bolts, nuts and washers, grouting packing and the like required for mounting and securing the equipment/assemblies should be included in the supply.

Bidders shall furnish guaranteed technical particulars (GTPs) in the Schedules enclosed. Drawings of all components shall be provided together with the equipment type and reference number to ensure their identification.

The unloading of the goods (items) in the purchaser's warehouse shall be in the scope of the suppliers.

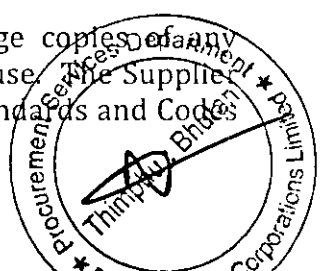
1.3 Units of Measurement

Metric units of measurement (System International) shall be used on all Contract documentation. Angular measurement shall be in degrees with 90 degrees comprising one right angle.

1.4 Standards

The design material, construction, manufacture, inspection and testing of all equipment supplied under this Specification shall conform to the latest editions of the International Electro-technical Commission (IEC) Specifications and other international standards where the material is not covered by IEC. Other national or international standards are accepted if they promise to confer equal or superior quality and performance than IEC or the specified standards.

The Supplier shall provide to the Purchaser, English language copies of any Standards and Codes of Practice, which the Supplier wishes to use. The Supplier shall provide Notarised English language translations of any Standards and Codes



of Practice which the Supplier wishes to use and which are in a language other than English.

1.5 Language

The English language shall be used on all Contract documents, drawings and calculations and in all correspondence between the Supplier and the Purchaser. Any documents and drawings submitted by the Supplier in the language other than English to the Purchaser will be returned to the Supplier without review by the Purchaser.

1.6 Site Conditions

1.6.1 The conditions for the design of the equipment are as follow:

Basic Design Parameters	Basic Design Value
Altitude	2400 metres
Ambient Air Temperature : minimum Maximum	-20°C +40°C
Average Annual Isokeraunic Level	75 thunderstorm days
Average Annual Rainfall & Period	1400 mm (May to September)
Climate	Varied (From tropical to severe winters)
Relative Humidity	20 – 100%
Seismic Acceleration : Horizontal Vertical	0.1 g 0.05 g
Snow Incidence and period	150 –300 mm (December to March)
Wind Pressure : Conductors Towers, Supports	45 kg/m^2 195 kg/m^2

1.6.2 Special Conditions

The equipment under this tender shall be designed for 2400m and accordingly shall the equipment/components shall be altitude corrected to 2400m.

1.7 Electrical Design Parameters

The electrical parameters of the equipment in accordance with relevant IEC and IS standards for 33kV and below are shown in following tables.

Medium Voltage

Nominal System Voltage	kV	33	11	6.6
Nominal System Frequency	Hz	50	50	50

Maximum System Voltage	kV	36	12	7.2
Rated Impulse withstand voltage (Peak)	kV	170	75	60
Rated one minute power frequency withstand voltage (rms) kV		70	28	20
Rated one second short time current (rms) kA		16	20	20
Rated short circuit withstand current (peak) kA		40	50	50
Creepage Distance	(mm/kV)	25	25	25

Low Voltage

Insulation parameters- Low Voltage

Nominal System Voltage	**V**	**400/230**
Nominal System Frequency	Hz	50
Maximum System Voltage	V	424/244[1]
Rated one minute power frequency withstand voltage (rms) V		3000
Rated impulse withstand voltage (peak)	kA	7500

Note 1: Phase to Phase / Phase to Neutral

System Variation

Parameters permissible at 75 °C		**Variation**
Voltage Regulation of MV System	33,11,6.6 kV	±10%
Voltage Regulation of LV System	400/230 V	±6%
System Frequency	50 Hz	-2%, +1% [1]
Parameters permissible at 75 °C		Variation

Note 1: Maintain the System frequency between 49.0-50.5Hz.

1.7.1 De-rating

Since various standards or recommendations enforce validity limits on device characteristics, therefore the values mentioned in this specification are for the normal condition of use i.e. below 1000 m. Beyond these limits, it is necessary to deduce certain values, in other words to de-rate the device. De-rating must be considered;

- For insulation level of external insulation.
- For electrical clearances of two conductive parts measured through air.

1.7.2 Basic Insulation Level (BIL) De-rating According to Altitude

For installation at an altitude higher than 1000 m, the correction method recommended in IEC 60694 is convenient to use for purpose of the determination of withstand test voltages.

1.7.3 Electrical Clearance De-rating According to Altitude

If the equipment is specified for operation at an altitude higher than 1000 m, the clearance requirements shall be increased by 1.25% for every 100 m by which the altitude exceeds 1000 m. Requirements are given for phase-to-earth; phase-to-neutral and phase-to-phase clearance.

1.8 Spare Parts, Tools and Appliances

The bidder shall attach the spares, special tools and/ or appliances which are recommended.

The Purchaser may order all, none or any of the recommended items. Those ordered shall be delivered not later than the date of receipt of the last shipment of the associated item of plant. The price of the items shall be subject to the same price conditions as the associated item of plant.

All spares shall be interchangeable with the original parts. They shall be treated and packed for long term storage under the climatic conditions of site.

Each item shall be clearly and permanently labeled on the outside of its container with its description and purpose. When several items are packed in one case, a general description of the contents shall be given on the outside of the case. Spare parts shall not be shipped in the same cases as components, which are used for erection. The cases shall be clearly labeled to indicate that they contain spare parts or tools and each tool or appliance shall be clearly marked with its size and purpose.

All case containers or other packages are liable to be opened for inspection and checking on site.

The cost of recommended spares, special tools (other than those specified in the BOQ) will not be taken into consideration when comparing bids.

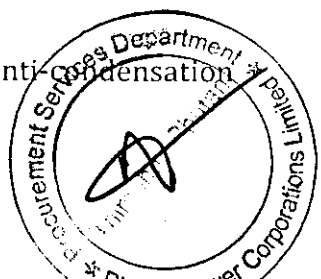
1.9 Electrical Power Supplies

a) Power Supplies

Power supplies for plant and equipment shall be:

i. 400 V, 3 phase, 4-wire, 50 Hz for power.

ii. 230 V, 1 phase, 50 Hz for lighting, indication, and anti-condensation heaters.



b) Miniature Circuit Breakers

Means shall be provided for protection and isolation of circuits associated with protection, control and instruments. They shall be of approved type and grouped, as far as possible, according to their functions. They shall be clearly labeled both on the panels and the associated wiring diagrams.

Miniature circuit breakers shall be of the thermal and magnetic tripping type, and comply with IEC 60898 and IEC 60947-2.

c) Terminals

Moulding materials shall be self-extinguishing or resistant to flame propagation, substantially non-hygroscopic and shall not carbonise when tested for tracking. The insulation between any terminal & framework or between adjacent terminals shall withstand a test of 2 kV rms. for one minute. The mouldings shall be mechanically robust to withstand handling while making terminations.

All terminals shall be mounted in accessible positions. Adjacent terminals shall be adequately spaced with respect to each other and to the incoming cable gland plate. Separate terminations shall be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores.

Terminations for circuits operating at Voltages greater than 60 V shall be protected by transparent insulating covers marked with the working Voltages.

DC circuit terminals shall be segregated from AC terminals.

Unless otherwise specified, all the terminal blocks except the terminal blocks for CTs shall be suitable for connecting minimum two 2.5 sq.mm copper conductors of the external cables at each connecting point. The terminal blocks for CTs and PTs shall be suitable for connecting minimum of 4.0 sq. mm and 2.5 sq. mm copper conductors respectively.

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

The terminal assemblies shall give the required number of ways plus 20% spare with a minimum of 5 terminals. These shall be uniformly distributed on all rows of terminal blocks.

d) Electrical Insulation

Insulating materials shall be finished to prevent deterioration of their qualities under the specified working conditions.

Plastics, elastomers, resin-bonded laminates and inorganic materials shall be of suitable quality selected from the grades or types in the appropriate IEC Standard.

All cut or machined surfaces and edges of resin-bonded laminates shall be cleaned and then sealed with an approved Varnish as soon as possible after cutting.

e) Alternating Current Supply Practice

Double-pole switches shall be used to break single-phase ac mains supplies. For multi-phase supplies, each phase shall be switched simultaneously and the neutral should preferably not be switched. If it is switched, it shall be opened after and closed before the phase-lines.

All mains circuits shall be protected only in the phase-lines by MCBs of suitable rating or by other suitably approved protective devices. The neutral shall be connected by a removable link located near the protective devices.

All main transformers shall have an electrostatic screen, which shall be earthed.

f) Direct Current Supply Practice

Double pole switches shall be used to break dc supplies, one pole for the positive line and one pole for the negative.

DC circuits shall be protected by MCBs of suitable rating installed in both positive and negative lines.

Measures shall be taken to prevent arcing across switches or relay contacts which are required to break inductive circuits (e.g. bypass diodes or capacitors connected across coils).

Power supply bus bars in cubicles shall be shrouded.

The duplicate auxiliary power supply feeders shall be provided in Control panels. Auto-changeover facility in DC DB shall be provided so that in case of failure of one power source, other shall cut in automatically. The protective relays shall not give a trip signal for momentary loss of control Voltage or during changeover of control Voltage.

g) Batteries

Electronic equipment shall not use local internal batteries unless the approval has been obtained. Where approval is given, batteries used inside equipment shall be of the totally sealed, leak-proof type.

h) Earthing

Provision shall be made for earthing all equipment intended for connection in an ac mains supply.

All structural metal work and metal chassis shall be connected to earth. Earthing conductors shall be at least equal in cross-sectional area to the supply conductors and shall be capable of carrying the fault current for 1 second.

i) Anti-Condensation Heaters

Any items of electrical equipment which are liable to suffer from internal condensation (due to atmospheric or load variations) shall be fitted with heating devices suitable for electrical operation at 230 Volts ac, 1 phase, 50 Hz of sufficient capacity to raise the internal ambient temperature by 5°C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energised while the apparatus is in operation. Where fitted, a suitable terminal box and control switch shall be provided and mounted in an accessible position. A thermostat shall be provided in the heater control circuit to cut-off the heater at 45° C.

j) Interior lighting and Receptacles

The panels shall be provided with a compact fluorescent lamp (CFL) lighting fixture (11 W) rated for 240 V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. Switching of the fitting shall be controlled by the respective panel door switch. All CFL lamps shall be with pin type holder.

The panels shall be provided with a 230 V, 1 phase, 50 Hz, 6 Amps, 3 Pin receptacle with switch. The receptacle with switch shall be mounted inside the panel at a convenient location.

1.10 Materials and Finishes

1.10.1 General

Unless otherwise provided for in the Contract, all materials, fixtures, fittings, and supplies furnished (hereafter called "materials") shall be new and of standard first grade quality. All assembly and construction work shall be done in a neat and professional manner. Materials shall be free of defects. Materials shall be brought to site only after inspection and issuance of proper dispatch clearance. The dispatch clearance shall be issued within three working days after the inspection from the BPC head office. The local materials like bricks, sand aggregates shall be tested in the local laboratories before bulk supply.

All of the plant, whether temporary or permanent, shall be in accordance with the Contract with respect to character, type, construction, constituent substances, weight, strength, shape, dimensions, etc.

In choosing materials and their finishes, due regard shall be given to the harsh climatic conditions which can occur in the area. Some relaxation of the following provisions may be permitted where equipment is hermetically sealed, but weatherproof materials should be used wherever possible.

All structural members, nuts and bolts shall be galvanised and shall conform to the requirements.

1.10.2 Surface Coating and Galvanising

All ferrous metalwork shall be provided with an effective galvanised or corrosion resistant paint treatment applied in accordance with the best trade practice. The paint treatment for each application shall be selected from the 'Paint Procedure' described in subsequent paragraphs.

The formulation and application procedure for the paint shall be as recommended by the manufacturer for the appropriate exposure conditions.

Coatings shall not be applied before vessels and chambers have passed any required pressure or vacuum tests. Precautions shall be taken to prevent corrosion occurring in the period of time between cleaning of the steel and commencing the painting.

Adequate amounts of each type and colour of finish coat as applied to the major equipment items shall be provided for "touch-up" purposes.

The colour of equipment shall be painted with RAL 7032 (exterior) and glossy white (interior).

1.10.3 Paint Procedure

(a) For Mild Steel Items Exposed to Weather:
  (i) Blast clean.
  (ii) 1st coat - Inorganic zinc primer to give a dry film build of not less than 75 microns.
  (iii) 2nd coat - Chlorinated Rubber to give a dry film build of not less than 100 microns.
  (iv) 3rd coat - Chlorinated Rubber to give a dry film build of not less than 75 microns.

(b) Mild Steel Items Immersed in Oil :
  (i) Blast clean.
  (ii) 1st and 2nd coats - Epoxy paint treatment system in accordance with coating manufacturer's recommendation for oil immersion.
  (iii) Total dry film build thickness shall not be less than 350 microns.

1.10.4 Galvanising

Galvanising shall be applied by the hot dipped process generally in accordance with ASTM A 123-78 for structural steel and ASTM A 153-73 for iron and steel hardware.

For structural steel, galvanising shall average not less than 0.61 kg/m^2 (no individual specimen shall show less than 0.55 kg/m^2) except for 6.35 mm and heavier materials in which case galvanising shall average not less than 0.702 kg/m^2 (no individual specimen shall show less than 0.61 kg/m^2).

For iron and steel hardware, galvanising shall be in accordance with Table 1 of ASTM A 153-73.

The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

1.10.5 Castings

All castings shall be free from blowholes, flaws and cracks as far as is practicable. No welding, filling or plugging of defective parts shall be done under any circumstances. All cast-iron shall be of close-grained quality approved by the Engineer.

1.10.6 Welding

All joints shall be bolted joints and welded joints shall not be permitted either during the design stage or the construction stage. However, during erection in case of additional unforeseen requirements by the Employer, if welding needs to be resorted to, the same shall be done with prior approval of the Engineer, and shall conform to BIS specifications. In such a case, the Contractor shall specifically indicate the location and purpose along with the proposed methodology for welding for the Engineers' approval. The wielding shall be carried out by a certified welder who have undergone minimum of certificate level training in this trade.

1.10.7 Nuts and Bolts

Nuts and bolts for incorporation in the plant shall conform to ISO Metric. Other sizes or threads may be permitted only for threaded parts not to be disturbed once manufacturing is complete. Each bolt shall have rolled threads, one hexagonal nut and two washers. Thread length shall be 50 percent of bolt length or maximum 150 mm.

All steel bolts and screwed rods shall be galvanised including the threaded portions. All associated nuts shall be galvanised with the exception of the threads which shall be oiled. The thickness of zinc coating shall be not less than 0.45 kg/sq. metre of surface area.

All bolts, nuts and washers shall be of non-corroding material where they are in contact with non-ferrous parts in conductor clamps and fittings and elsewhere where specifically required by the Purchaser.

1.11 Packing and Shipping

1.11.1 The goods/materials shall not be shipped/ dispatched unless dispatch clearance from Purchaser/Engineer is issued. The dispatch clearance will be issued from the BPCs office after the inspectors submits its inspection report to BPC, within 4 working days after the submission of the report.

1.11.2 Any items liable to be damaged in transit shall be effectively protected and securely fixed in their cases. All cases of over 2 tonnes shall be marked to show where slings should be placed.

1.11.3 All cases shall be clearly identified giving particulars of manufacturer's name and type of equipment. All identification marks on the outside of cases shall be waterproof and permanent. All electrical equipment shall be adequately sealed and desiccating agents used where necessary to prevent damage from condensation. All equipment shall be packed and protected, bearing in mind that it will be shipped to a harsh environment, that a considerable period may elapse between its arrival on site and it's unpacking and that covered storage may not always be possible.

1.11.4 All wood and other materials used in packing cases shall be insect free. Adequate protection and precautions are to be taken to exclude termites and other vermin, noxious insects, larvae or fungus from the packing materials or plant. All contents are to be clearly marked for easy identification against the packing list.

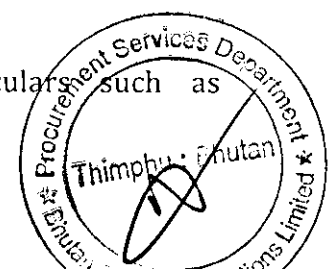
1.11.5 The Supplier shall protect all steelwork before shipment, to prevent corrosion and/ or damage. Bundles of steel sections shall be properly tied together by an approved method and care shall be taken to ensure that they are robust and that they can be handled easily during shipment.

1.11.6 Bolts and nuts shall be double bagged and crated for shipment. Crating of dissimilar metals is not acceptable.

1.11.7 Packing cases where used, shall be strongly constructed and in no case shall timber less than 25 mm in thickness be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood, but shall be supported by cleats secured from inside.

1.11.8 The following information shall be marked on the containers/cartons as well as boxes:

a) Supplier's name, Project title and Contract reference
b) Identification number
c) Net/Gross weight
d) Purchaser's name with other despatch particulars such as destination.



1.12 Labels

1.12.1 All equipment shall be provided with labels or name plates, giving a description of the equipment, together with information regarding the rating, nominal voltage, nominal current and the like under which the item of plant in question has been designed to operate. The labels shall be provided on packaging to the Purchaser's approval.

1.12.2 Such nameplates or labels are to be of non-corrodible, non-hygroscopic material with lettering of a contrasting colour.

1.12.3 Labels on cable drums shall state the cable details, including the length in metres.

1.13 Locks

Provision shall be made for padlocking of mechanism boxes, isolators and outdoor switchgear as required by the Specification or as necessary to limit access or the safety of personnel. All padlocks will be provided by the Purchaser.

1.14 Supplier Documents and Drawings

1.15.1 General

The Supplier shall be responsible for submission, re-submission and obtaining approval as required of all the documents and drawings listed below (but not limited to), so that there shall be no delay to the work due to the absence of such documents and drawings. Any approval by the Purchaser will not relieve the Supplier of any obligations under the Contract.

Any alterations to the documents and drawings which may be required by the Purchaser for approval shall be made by the Supplier at his own expense. All materials and work involved in their manufacture shall be as indicated in such drawings.

No work shall be done on any part of the Goods, the design or construction of which is dependent on the approval of such drawings or data, until such approval has been given.

1.15.2 Manner of Submission and Approval of Drawings

The Supplier shall submit two prints (one copy if it is mailed) of each drawing or document for approval. The Supplier shall provide the same number of further prints for any drawings that are altered. The submission of drawings for approval shall be repeated until 'Approved' or 'Approved with conditions' is given by the Purchaser.

Within fifteen working days after receipt by the Purchaser of any drawing or document requiring the Purchaser's approval, the Purchaser shall either sent one

copy thereof to the Supplier with its approval endorsed thereon or shall notify the Supplier in writing of its disapproval thereof and the reasons therefore and the modifications that the Purchaser proposes.

All drawings, information, design reports, etc shall be neatly type written and be presented as bound documents. The documents presented shall have neatly drawn title pages that clearly show the name of the Purchaser, identify the project name, the contract number, the date, the revision number, etc, and shall be provided with a table of contents.

1.15.3 Manuals

The Supplier shall submit the instruction manual for all the goods supplied under the contract. The Supplier shall follow the requirements as mentioned in the relevant clauses in the Technical Specifications.

1.15 Quality Assurance

1.16.1 The manufacturer must operate a quality assurance system that complies with ISO 9000. The Supplier shall provide current certification showing the manufacturers' compliance with ISO 9000 or equivalent national standard. The certificate must be issued by an independent, accredited issuing authority.

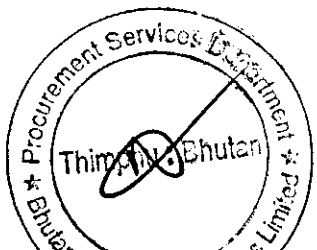
1.16.2 In compliance with the proposed quality assurance system of ISO 9000 or equivalent, Bidder shall submit with Bid the quality assurance plan for manufacturing the Goods. Especially, if the Bidder proposes to form a joint-venture or consortium, such a Bidder shall submit with Bid a quality assurance plan, including explanation how to manage the same quality of Goods by the joint-venture partners.

1.16 Tolerance

The variation in quantity to be supplied against confirmed order shall be permissible up to One (1) percent per item per consignee for delivery. However, for the short supply the payment shall be made as per the actual supply and for over supply the payment shall be limited to the ordered quantity.

1.17 Inspection and Testing

The materials will be inspected at the Manufacturer's works by the Purchaser's representative. Tests shall be performed in accordance with the relevant IEC standards. In the absence of IEC recommendations the tests must be equivalent at least to the conditions, provisions and definitions of the above-mentioned standards. The supplier shall give at least one month's notice for readiness of equipment for testing at the manufacturer's works. The tests shall be divided into the categories described below.



1.17.1 Routine Tests

All the routine tests specified by the standards shall be carried out. If the tests are not witnessed by the Purchaser's representative, test certificates shall be submitted to the Purchaser for approval. Despatch clearance will be given only if the test results are approved.

1.17.2 Type Tests

Bidder shall include with his bid type test certificates, issued by an approved, reputed, independent testing laboratory.

In addition, the Purchaser may call for type tests to be carried out at the Manufacturer's Works and to be witnessed by the Purchaser or his representative. Such tests will be on random samples at the discretion of the Purchaser and failure to meet the conditions of test could result in the rejection of a complete batch of equipment. Type testing shall only be performed if the manufacturer is unable to provide type test certificates issued by an independent test laboratory of international repute.

1.17.3 Inspection

The Supplier shall intimate the Purchaser about the detailed program about the tests and inspection at least one month in advance.

Inspection and tests on all the Goods offered shall be carried out in the presence of Purchaser's representative unless inspection waiver has been given to the Supplier. The inspection shall be carried out as per the test procedure that has been approved by the Purchaser. The Supplier shall assist the work of the Purchaser's inspector by providing copies of all relevant Standards and test procedures, and allowing the inspector full use of the necessary tapes, measures and laboratory equipment, together with ample space and assistance in the handling of Goods for inspection.

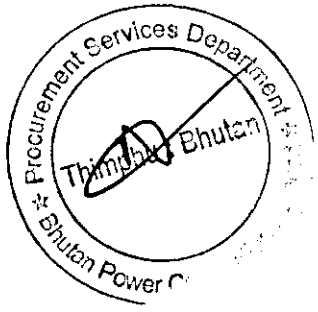
The Supplier shall submit all final test and inspection reports to Purchaser's representative (inspector) during his stay at the workshop for the inspection. The inspector shall issue a "Dispatch Clearance" to the Supplier when the tests and inspection has successfully completed in compliance with the Technical Specifications.

1.18 Dispatch Clearance

1.18.1 The Supplier shall submit all final test and inspection reports to Purchaser's representative (inspector) during his stay at the workshop for the inspection. The inspector shall issue a "Dispatch Clearance" to the Supplier when the tests and inspection has successfully completed in compliance with the Technical Specifications.

1.18.2 The goods have to reach to the delivery warehouse within Twenty (20) days from the date of issuance of dispatch clearance (if the goods are supplied/manufactured from India & Nepal).

1.18.3 The goods have to reach to the delivery warehouse within Forty Five (45) days from the date of issuance of dispatch clearance (if the goods are supplied/manufactured from Third Countries).



2. Test Standards

1. Standards

The design material, construction, manufacture, inspection and testing of all equipment supplied under this Specification shall conform to the latest editions of the International Electrotechnical Commission (IEC) Specifications and other international standards where the material is not covered by IEC. Other national or international standards are accepted if they promise to confer equal or superior quality and performance than IEC or the specified standards.

2. Testing

The tests shall be divided into the categories described below.

2.1 Routine Tests

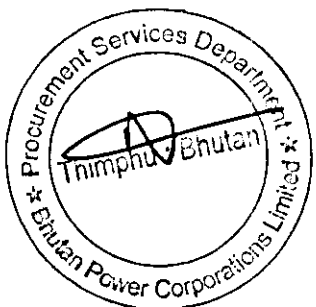
All the routine tests specified by the standards shall be carried out. If the tests are not witnessed by the Purchaser's representatives, test certificates shall be submitted to the Purchaser for approval. The test certificates must show the actual values obtained from the tests, in the units used in this Specification, and not merely confirm that the requirements have been met. No materials shall be dispatched until the test certificates have been received by the Purchaser and the Supplier has been informed that they are acceptable.

Despatch clearance will be given only if the test results are approved.

2.2 Type Tests

Bidder shall include with his bid type test certificates, issued by an approved, reputed, independent testing laboratory. Type tests shall be carried out at an independent testing laboratory or be witnessed by a representative of such laboratory or some other representative acceptable to the Purchaser. Type tests may be dispensed with at the Purchaser's discretion, if the Supplier furnishes evidence to the Purchaser's satisfaction, that the relevant tests have already been performed on identical materials and equipment.

In addition, the Purchaser may call for type tests to be carried out at the Manufacturer's Works and to be witnessed by the Purchaser or his representatives. Type testing shall only be performed if the manufacturer is unable to provide type test certificates issued by an independent test laboratory of international repute. Such tests will be on random samples at the discretion of the Purchaser and failure to meet the conditions of test could result in the rejection of a complete batch of equipment.



3. Inspection and Testing for Switching Equipment, Surge Arresters

Tests to establish whether the performance guarantees in the Schedules have been met shall be carried out by the Contractor, to the satisfaction of the Purchaser.

Type and routine factory tests shall comprise the following:

- Insulation level tests, including withstand tests at power frequency voltages on auxiliary equipment.
- Temperature rise test.
- Rated peak withstand current and rated short-time withstand current tests.
- Tests to prove satisfactory operation and mechanical endurance.

4. Inspection and Testing for Distribution Pillar

The Distribution Pillar shall be subject to following tests:

- High voltage test (2000V for 1 minute)
- Megger test
- Electrical control, interlocking and sequential operation test.

5. Inspection and Testing for Insulators

Insulators shall be tested in accordance to the requirements of the following standards in respect to type tests, unless certification is already available for the exact type being supplied, routine tests and sample tests.

• IEC	Radio Interference characteristics of overhead
• IEC 60	High Voltage Test Techniques
• IEC 120	Dimensions of ball and socket coupling string insulators units
• IEC 305	Characteristics of string insulators of the cap and pin type
• IEC 372	Locking devices for ball and socket couplings of string insulator units: dimensions and tests
• IEC 383	Tests on insulators of ceramic materials and glass
• IEC 437	Radio interference test on high voltage insulators
• IEC 506	Switching impulse tests on high voltage insulators
• IEC 507	Artificial pollution tests on high voltage insulators to be used on A.C. systems
• IEC 575	Thermal - mechanical performance tests and mechanical performance test on string insulator units
• IEC 591	Sampling rules and acceptance criteria when applying statistical control methods for mechanical and electromechanical tests on insulators
• CISPR 18-2	Power lines and high voltage equipment
• IEC 797	Residual strength test
• ANSI C29.2	Impact strength test
• ASTM C151	Autoclave expansion of Portland Cement test

- BS 729 Hot dip galvanized coating on iron and steel articles
- BS 443 Specification for testing zinc coatings on steel wire for quality requirement.

Tests shall be carried out on random insulators taken from batches offered for inspection. The number of samples shall be selected as per IEC 383 with a minimum of five units. The samples shall be subjected to the following tests after having been subjected to routine tests in the same order:

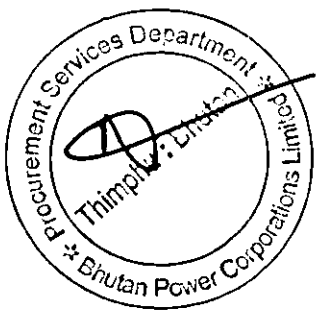
(a) Verification of dimensions
(b) Temperature cycle test
(c) Electro-mechanical or mechanical failing load test in accordance with the type of insulator, including thermal-mechanical performance test to IEC 575.
(d) Puncture test
(e) Porosity test
(f) Galvanising test

In the event of one unit failing to pass any of the sample tests, a further quantity, double that of the first quantity shall be subject to retesting. In the event of two or more insulators or metal parts failing to pass any of the sample tests, or if any failure occurs on insulators or metal part subject to retesting, the complete batch will be rejected.

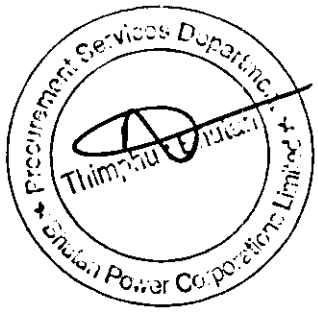
12.1 Type Tests

Bidders shall include with their offers type test certificates, including thermal, mechanical performance carried out in accordance with IEC575, which are issued by an approved, internationally acknowledged, reputed, independent testing laboratory. When type tests are called for by the Purchaser, they will comprise the following:

1.1 Dry lightning impulse withstand voltage test
1.2 Wet power frequency withstand voltage test



Technical Specification for Lot 1 (Lubricants)



1. Transformer Oil

1.1 The insulating oil shall conform to all parameters either as per IEC-60296 and latest edition or as specified below, while tested at supplier's premises. No inhibitors shall be used in oil. The supplier shall furnish test certificates from the supplier against their acceptance norms as mentioned below, prior to despatch of oil from refinery to site.

Sl. No.	Characteristics	Requirements	Method of Test
1	Appearance	The oil shall be clear and transparent and free from suspended matter or sediment	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient
2	Density at 20°C (max.)	895 kg/m³	IEC 60296
3	Kinematic Viscocity at27°C (Max.)	27 cSt	IS: 1448
4	Interfacial Tension at27°C (Min.)	43mN/m	IEC 60296
5	Flash point Penskey-Marten (closed) (Min.)	Min 135°C	IEC 60296
6	Pour point (Max.)	-40°C	IEC 60296
7	Neutralization value (total acidity) (Max.)	0.03 mg KOH/gm	IS: 335 Appendix-1
8	Corrosive sulphur (in terms of Classification Of copper strip)	Non-Corrosive	IEC 60296
9	Electric strength (Breakdown voltage) (Min.)		
a)	New untreated oil	30 kV (rms) (if this value is not attained the oil shall be treated)	IS: 6792
b)	After Treatment	60 kV (rms)	-

Sl#	Characteristics	Requirements	Method of Test
10	Resistivity (Min.) (ohm cm)		IS: 6103
b)	at 27°C	1500×10^{12}	
11	Oxidation stability		
a)	Neutralization value after oxidation (Max.)	0.40 mg KOH/gm	
b)	Total sludge after oxidation (Max)	0.05 %	IEC 60296
12	Presence of oxidation inhibitor	The oil shall not contain anti-oxidant additives	IS: 335 Appendix-D
13	Water content (Max.)		
a)	New untreated oil	50ppm	IS: 2362
b)	After treatment	15ppm	IS: 1866
14	Aging Characteristics after 96hrs as per ASTM-D1934/IS: 12177 with catalyst (Copper)		
a)	Resistivity(Min) (ohm cm) at 27°C at 90°C	 2.5×10^{12} 0.2×10^{12}	
b)	Tan delta at 90°C (Max.)	0.05	
c)	Total acidity (Max.)	0.3 mg KOH/gm	IEC 60296
d)	Sludge content wt. (Max.)	0.05 %(By weight)	
15	PCB Content	Less than 2 ppm	

1.2 Subsequently oil samples shall be drawn

(i) Prior to filling in main tank at site and shall be tested for:

(1) BDV.
(2) Moisture content.

(ii) Prior to energisation at site and shall be tested for following properties & acceptance norms:

(1)	BDV (kV rms)	60 kV (min.)
(2)	Moisture content	15 ppm (max.)
(3)	Tan-delta at 90°C	0.05 (max.)
(4)	Resistivity at 90°C	1 x 10^{12} ohm-cm (min.)
(5)	Interfacial Tension	0.03 N/m (min.)

1.3 At manufacturer's works oil sample shall be drawn before and after heat run test and shall be tested for following:

(1)	BDV	60 kV (min.)
(2)	Moisture content	15 ppm
(3)	Dissolved gas analysis (DGA):	

Samples for DGA shall be taken from sampling device within 24 hours prior to commencement of temperature rise test and immediately after this test. The acceptance norms with reference to various gas generation rates during the temperature rise test shall be as per IS: 10593 (based on IEC-599).

2. Coolant Conditioner for DG Set

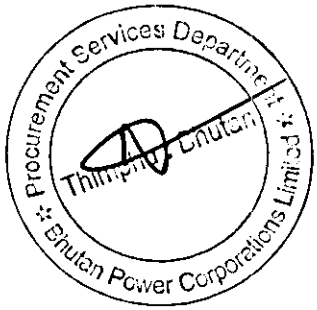
215-4242: CAT® ELC PREMIX

SPECIFICATIONS

- Container Type: Drum
- Drain Interval: 12,000 hours with S•O•S(SM)

Sample Picture

Technical Specification for Lot 2 (Paints)



1.0 Aluminium Paints with Paste

1.0 General

The properties of Aluminium paint should be highly resistant to moisture, saline water and general corrosive conditions. It should be excellent for protection of underwater and underground installations and also for various exposed parts of structures, and machines etc. which are prone to corrosion because of entrapment of moisture and other natural phenomena.

1.2 Specification of the Paints

i.	IS Standard	:	158 and 9862(Latest edition)
ii.	Colour	:	metallic aluminium
iii.	Finish	:	Semi gloss with low metallic luster, smooth & lustrous
iv.	Flash Point	:	Above 30ºC
v.	Mixing	:	**Should be proportionately mixed with paste for ready use.**
vi.	Recommended Dry film thickness	:	20 microns per coat
vii.	Corresponding Wet film thickness	:	80 microns
viii.	Drying time	:	Touch dry- 4 hours Hard dry 12 – 18 hours
ix.	Dry heat resistance	:	Up to 120º C (intermittent)
x.	Storage life	:	Up to 12 months under standard warehouse storage conditions.

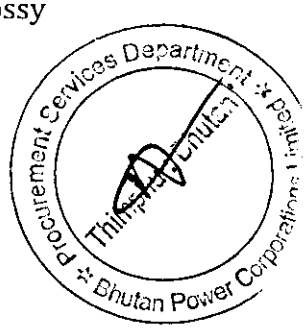
2.0 Bituminous Black Paints

2.1 General

A specially treated anticorrosive bituminous coating primarily designed to give long term protection to electrical poles and structures. The coating should have excellent water resistance characteristics along with resistance to impact and abrasion.

2.2 Specification of the Paints:

i.	IS Standard	:	158 and IS 9862 (Latest Edition)
ii.	Colour	:	Black
iii.	Finish	:	smooth and Semigloss to Glossy
iv.	Flash Point	:	Min 30^{0}C
v.	Volume Solids	:	56 % approximately
vi.	Recommended		
•	dry film thickness	:	30 microns per coat
vii.	Corresponding		
•	wet film thickness	:	54 microns
viii.	Drying time	:	Touch dry– 6 hours



		:	Hard dry- 24 - 48 hours
ix.	Dry Heat Resistance	:	Up to 120ºC (intermittent)
x.	Storage life	:	Up to 12 months under standard warehouse storage conditions.

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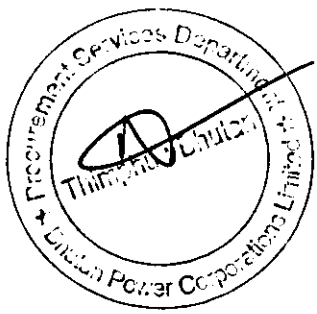
Technical Specification for Lot No. 3 (MCCB)



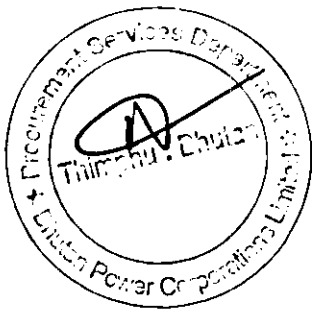
1. Moulded Case Circuit Breaker (MCCB)

MCCBs shall be heavy duty type, mounted on bases, having a rupturing capacity of 50 kA at 415V A.C. 50 Hz. Outgoing MCCBs are to be supplied and installed as part of the completed LV switchboard with the following parameters.

Table 1. Specification of MCCB

Sl. No.	Description	Unit	Particulars
1	Applicable Standard		IEC 60947-2
2	Rated Frequency	Hz	50
3	Phase	Ph	3
4	Rated Current	Amps	25,50,63,100,125,160,200,250,400,630, 800 as per requirement
5	Rated operational voltage	V	415
6	Breaking capacity	kA	50
7	Release	-	Static
8	Type	-	Manual/Fixed

Technical Specification for Lot No. 4 (Distribution Boxes)



1. Distribution Boxes

1.0 Scope

This specification covers the design, manufacture, testing at manufacture's work before dispatch, packing and transportation to BPC stores.

1.1 Code and Standard:

The construction, inspection and testing of the feeder pillar shall comply with all currently applicable status, regulations and safety codes in the locality where the feeder pillar will be installed. The feeder pillar drawing is attached herewith.

The applicable standards: IS 5039 and IS 13703 part 2

1.2 Construction Features:

1.2.1 The Distribution Pillar shall be sheet steel enclosed and should be robust, dust, weather and vermin proof providing a degree of protection of IP 52 for indoor use and IP 54 for outdoor use. Sheet steel used shall be cold rolled grain oriented (CRGO) and at least 2.5 mm thick smooth finished, leveled and free from flaws and properly braced to prevent wobbling.

1.2.2 The Distribution pillar shall be provided with hinged doors openable from the center. It should be also provided with IEC standard type lock and pad locking arrangement.

1.2.3 Doors, removable covers, if any and plate shall be gasketed all around with neoprene gaskets, and this is essential to prevent ingress of dust and vermin.

1.2.4 All live parts shall be provided with at least phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively.

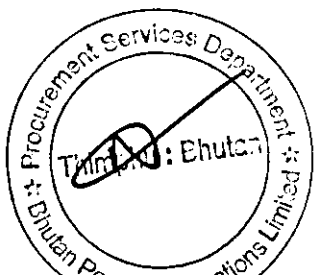
1.2.5 The suitable removable cable gland plate of 2.5 mm cold rolled sheet steel should be provided. The interior cabling space should be strictly as per drawing attached.

1.2.6 The external earthing terminal with M10 and 19 mm x 6 mm Aluminum alloy of E91E grade earthing strip inside should be provided.

1.3 Painting:

1.3.1 All parts shall be cleaned in a six stage surface prep machine prior coating, including:

- Heated alkaline wash;
- Fresh Water rinse;
- Heated iron phosphate coat;
- Fresh water rinse;



- Recirculated deionised water rinse;
- Fresh deionised water mist

1.3.1 After prepping, the equipment shall be dried at 250 degrees for 5-1/2 minutes.

1.3.2 Epoxy polyester hybrid power plant shall be electrostatically applied.

1.3.3 The coated parts are then oven cured for 20 minutes at up to 450 degrees to provide a furniture quality finish. The hot parts are cooled to ambient temperature prior to packaging.

1.3.4 After curing, the paint finish is inert and no volatile emissions are present. There are no fugitive (stray) emissions in the finished product.

1.3.5 Gloss: 50 – 60 degrees
Impact Resistance: 18.07 Nm
Flexibility: 180 degrees, ¼ "mandrel
Pencil hardness: 2H
Cross hatch adhesion: 100%
Salt spray: 200 hours minimum
Humidity resistance: 200 hours minimum
Micron thickness: 80 microns

1.4 Main Busbar:

1.4.1 Main busbar shall be of Aluminum alloy of grade E91E, and as specified in drawing and conforming to relevant standard IS: 5082.

1.4.2 Busbar shall be located in horizontal formation but with gradual gradient as indicated in drawing.

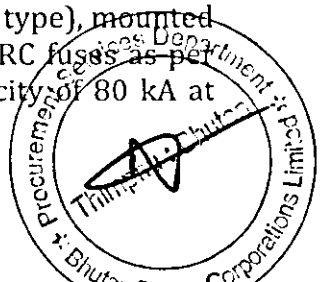
1.4.3 All busbar shall be a solid strip without joints and shall be rated continuously. The maximum temperature of the busbar under operating conditions when carrying rated normal current at rated frequency should not exceed 85°C.

1.4.4 Busbar shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current. Busbar support insulators shall conform to relevant standard IS: 2544.

1.4.5 Busbar should not be painted and all performance characteristics specified shall be obtained with unpainted busbars.

1.5 Fuses:

1.5.1 Generally, fuses shall be of HRC cartridge fuse link (Blade contact type), mounted on different sizes of fuse bases required for different sizes of HRC fuses as per requirement under the Price Schedule having a rupturing capacity of 80 kA at 415 V, A.C. 50 Hz.



1.6 Interior Lighting

1.6.1 The Distribution Pillar shall be provided with a 230V, single phase, 50 Hz, 40W, preferably incandescent lamp fixture placed diagonally opposite for interior illumination and controlled by a piano switch and HRC fuse link HF of 2 Amps for lamp.

1.6.2 The Distribution Pillar should be supplied completely wired, ready for the Bhutan Power Corporation Limited's external connections at the terminal blocks. All wiring should be carried out with 650 V grade, PVC insulated, 7/20 standard copper wire.

1.7 Labels and Danger Plate:

1.7.1 The Distribution Pillar shall be provided with individual component labels with pillar designation or rating. The danger sign as indicated in drawing should be drawn on every pillar. Both external-earthing terminals shall be levelled.

1.8 Colour of the Enclosure

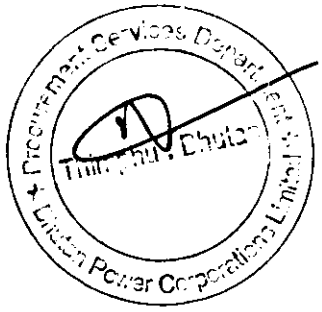
The colour of enclosure should be RAL 7035 (Light Grey).

1.9 Submission of Test Certificate & Drawings

The supplier shall provide the type test certificates for the boxes done within Ten (10) years from the reputed testing laboratory.

The Supplier shall provide to the Purchaser the drawings if the contract is awarded for the final approval.

Technical Specification for Lot No. 5A (Cable Termination Kit)



1. General Specifications

a. The cable accessories should be suitable for storage without deterioration in properties at temperatures up to 50 deg C and should have unlimited shelf life.

b. Fluorinated Silicon Grease should be provided for filling up the minor nicks & scratches on the insulation that may occur while removing the Semi conducting screen of the Cable.

2. END TERMINATIONS

a. Class of Termination: The End termination should be Class - I as defined by IEEE 48 Standard & amended up to date.

b. Stress Control :

- The stress control at the screen cutback should be provided by a Heat Shrinkable tubing having a minimum volume resistivity of 10^{10} Ohms cm. The relative permittivity of the tubing should be at least 15.

- To eliminate voids caused at the step due to semiconducting screen cutback, the manufacturer should provide a high permittivity mastic the permittivity of which should be at least 15.

- The impedance of the stress control tubing should not change over a range of temperature of 0 deg C – 125 deg C, which is the temperature range over which an XLPE cable is expected to operate

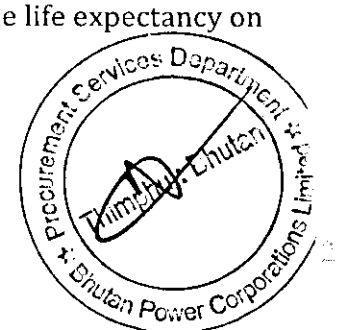
c. Protection to Insulation :

A heat shrinkable tubing should be applied over exposed cable dielectric.
The material should be:

(1) Non tracking
(2) Weather resistant
(3) Erosion resistant
(4) U. V. radiation resistant

Test reports conforming that there is no degradation of the material after prolonged exposure to elevated temperatures this should include

- Thermal endurance- An Arrhenius plot to confirm the life expectancy on continuous at a temperature of 90 deg C.



- The materials should pass Tracking & Erosion Resistant test in accordance with IEC 60587.

- The materials should be tested as per ISO 1431 for evaluating it's resistance to Ultra Violet radiations and Ozone.

d. Environment sealing :

At the lug end the sealing against ingress of moisture should be provided by non-tracking sealant strips followed by heat shrinkable non tracking, erosion & weather resistant tubing precoated with non-tracking sealant.

For 3 core cable the sealing at the crutch area should be provided by a heat shrinkable non tracking erosion & weather resistant breakout internally coated with a non tracking hot melt adhesive.

e. Provision for Earthing

The Copper tape screen and armour of the cable should be earthed by tinned copper braids of appropriate size provided with lug at one end.

3. STRAIGHT THROUGH JOINTS

a. Conductor Continuity

Proper conductor continuity should be ensured either by Crimping or by using Shear head bolted connector.

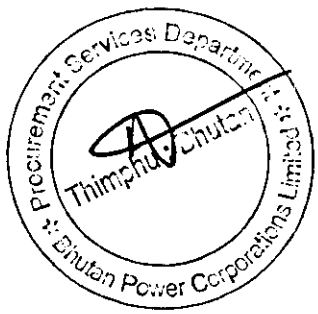
b. Stress Control :

- The stress control at the screen cutback should be provided by a heat shrinkable tubing having a minimum volume resistivity of 10^{10} Ohms cm. The relative permittivity of the tubing should be at least 15.

- To eliminate voids caused at the step due to semiconducting screen cutback , the manufacturer should provide a high permittivity mastic the permittivity of which should be at least 15.

- The impedance of the stress control tubing should not change over a range of temperature of 0 deg C – 125 deg C, which is the temperature range over which an XLPE cable is expected to operate.

c. Reinstatement of Insulation:



- This should be affected by means of a heat shrinkable, flexible, polymeric tubing made from discharge resistant polymer. The tubing after complete recovery should have a minimum wall thickness of 3 mm to ensure provision of adequate insulation in one step.

- To ensure a void free bond between the rebuilt tubing and screen the manufacturer should supply a single dual walled tubing. This enables the final insulating layer to be installed complete with a conductive polymeric screen.

- The kit should be provided with a high permittivity hot-melt mastic for applying over the ferrule to eliminate voids and sharp edges.

d. Armour/ Screen Continuity

The continuity of the copper tape screen should be affected by tinned copper Mesh and that of the armour by tinned copper braids of adequate cross section.

e. Environment Sealing :

The joints should be protected against ingress of moisture by a polymeric flexible heat shrinkable tubing precoated with hot melt adhesive. This should completely cover metallic sheaths/ earth connections.

4. TEST

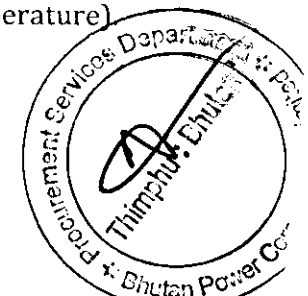
a. The termination and its components should be tested as per test sequence of VDE 0278 or IS: 13573 as per latest amendments

b. The Joints/ Terminations should be type Tested for series 1 and series 2 along with **SALT FOG TEST** at per testing procedures of IEC 60502-4.

c. The manufacturer should provide life assessment test (accelerated ageing test) reports to prove that the heat shrinkable components are capable of retaining their properties within acceptable limits during the course of long term usage.

d. TERT (Track Erosion and Resistance test) should be conducted on heat shrinkable tube used in termination to prove that they are non-tracking.

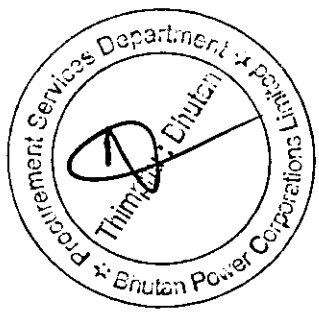
e. The manufacturer should also furnish graphs showing the variation of impedance of the stress control tubing with respect to (1) change in temperature and (2) Time (aging at constant temperature)



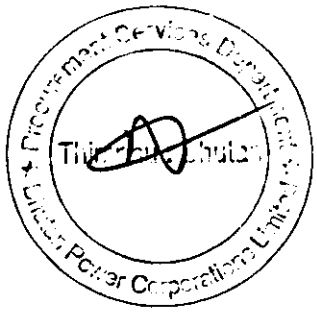
Jointing Kits (Outdoor/Indoor/Straight Through)

Sl No.	Particulars	Unit	Technical Particulars	
1	**Type**		Heat shrinkable type	
2	Applicable Standards		IS:13573	
3	Rated Voltage Uo /U(Um)	kV	6.35/11(12)	19.05/33(36)
4	AC Voltage withstand	kV(1min)		
	Dry		28	70
	Wet		35	75
5	Impulse voltage withstand(10 positive and 10 negative, 1.2us between each conductor and the ground screen)	kV	75	170
6	Partial Discharge	kV	12.7	38
7	Loading Cycle(60 cycle 5h heating, 3hcoolingconductortemperature: 5+operating temperature)		16	50
	Kit Particulars			
8	Materials of the tubing/moulded part		Heat shrinkable	Heat shrinkable
9	Method of stress control		Heat shrinkable	Heat shrinkable
10	Method of environment seal		As per IS Standard	As per IS Standard
11	Allowable Kit storage temperature	Degree	Unlimited	Unlimited
12	All the jointing kits(outdoor/indoor/straight through joint kit)is complete with all accessories	(Yes/No)	Yes	Yes

The above values are approximate. In case of any specific deviation in values, the same shall be brought out in the deviation sheet.



Technical Specification for Lot No. 5B (Cable Termination kit for 33kV GIS)



1. Cable Termination Kits for 33 kV GIS

Cable termination kits required for the project should be screened separable connectors, designed to connect single and three-core XLPE cables to medium-voltage gas insulated switchgears and other equipment using Type C bushing interface=630 A specified up to 33kV. The test shall be done as per IEC 61442-2005/IEC 60502-4

It should be made up of insulating material characterized by high tracking resistance, elongation at break and non-flammability. It should be protected by a thick walled outer conductive screen connected to earth and suited for indoor installations. The overall and cut back dimensions should be designed to take up minimum space in the terminal box.

- The screened connector need not be removed for over sheath testing. Conductor connection should be suitable for both mechanical lugs and crimping. Provision should be provided for cable testing without disconnecting the connectors from the bushings.

2. The minimum technical parameters required are mentioned below:

Sl. No.	Particulars	Unit	Technical Particulars
1	Maximum System Voltage	kV	36
2	Rated Current	A	630 A
3	Partial Discharge	pC	< 10
4	Basic Insulation Level	kV peak	170
5	AC HV Test voltage for 5 min	kV	85.5
6	DC HV Test for 15 mins	kV	114
7	Thermal Short Circuit Current Test for 1 sec		
a	3x300 sq. mm	kA	35
b	1Cx630 sq. mm	kA	75
8	Dynamic Short Circuit current test	kA	95 kA

The Cable termination kits shall be used for the Cables with following parameters:

Sl. No.	Specified Terms and Conditions	Units	1C x 630 sq.mm, 33kV	3 C x 300 sq.mm, 33kV
1	Manufacturer		Dynamics Cables Ltd, Jaipur	Dynamics Cables Ltd, Jaipur
2	Applicable Standard		IS 7098 part II	IS 7098 part II

3	Rated voltage	kV	19/33kV	19/33kV
4	System Voltage	kV	33kV	33kV
5	Maximum current carrying capacity			
a	Air	A	770	455
b	Ground	A	495	350
c	Duct	A	420	310
6	Short circuit capacity of conductor	A	59.2 KA for 1 sec	28.2 KA for 1 sec
7	**Conductor**			
	Material		Aluminium Conductor	Aluminium Conductor
	Crossectional Area	sqmm	630	300
	Whether Stranded?		Yes	Yes
8	**Insulation**			
	Material		XLPE	XLPE
	Thickness	mm	8.82 mm (min)	10.45 mm (min
9	**Inner Sheath**			
	Material		PVC Compund Type ST2	PVC Compund Type ST2
	Whether Extruded or Wrapped?		Extruded	Extruded
	Thickness	mm	Min 0.6	Min 0.7
10	**Outer sheath**			
	Material		PVC Compund Type ST2	PVC Compund Type ST2
	Thickness	mm	Min 2.36	Min 3.0
11	**Armour**			
	Material		Single layer aluminium Wire	Single layer Galvanized flat Steel Strip

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	Thickness	mm	2.5	1.4
12	Details of screen, if any			
13	Total overall diameter	mm	Approx. 60	Approx. 95
14	**Test Voltage**			
	One/five minute power frequency withstand voltage	kV	64kV for 5 min	64kV for 5 min
	Impulse withstand voltage	kVp	170	170
15	Type of cable end sealing		PVC end caps	PVC end caps
16	**Cable drums**			
	Dimensions	mm	1800x1000x850	2300x1300x1270
	Weight	kg	1240	2900
	Nominal length per drum	mtr	250± 5%	250± 5%

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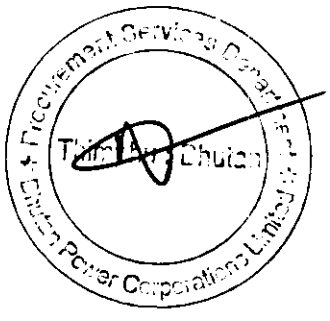
Bhutan Power Corporation Limited

Technical Specification for Lot No. 7 (Switching Equipment)



1.0 Scope

The works to be undertaken under this Contract are the design, manufacture, testing, supply and delivery of line switching equipment.

2.0 Extent of Supply

The design, manufacture, testing and delivery, including off-loading, of the following equipment for MV and LV distribution systems

a) 11 kV Drop-Out (DO) Fuse
b) 33 kV Drop-Out (DO) Fuse
c) 11 kV Air Break Switch
d) 33 kV Air Break Switch

3.0 Standards

The equipment covered in this Specification shall conform to the latest edition of the relevant IEC Standards.

Materials and components shall conform to the relevant IEC Publications or other internationally accepted Standards equivalent to the above Standards, subject to the approval of the Purchaser. Only fully type tested equipment shall be considered.

4.0 Drop Out Fuses for 11 kV and 33 kV

4.1 Drop Out (DO) Fuse

The DO fuse shall be of lightweight construction suitable for heavy duty performance. They shall be supported on robust porcelain insulators, mounted on vertical steel channels in single phase units. The design of the DO fuse shall ensure complete ease of installation and trouble free operation under all service conditions.

i) The fuse carrier shall drop down when the fuse element melts.
ii) The operating ring shall be suitable to accommodate most standard operating pole heads.
iii) The fuse carrier shall be of a fibreglass barrel, designed to accommodate standard expulsion fuse-links of the button head pattern with ratings from 1A to 200A.
iv) Each DO fuse unit shall be supplied complete with connection terminals suitable for conductors ranging in size from 16 mm^2 to 120 mm^2.
v) Units shall be operated from ground level by means of an insulated operating stick. An operating stick shall be provided for each DO fuse.

DO fuse are required to protect (and where necessary, provide isolation for) 33kV and 11kV distribution transformer circuits. They shall be provided with a latch mechanism, which will open the fused element when the fuse has operated.

The latch mechanism shall be constructed so as to be easily operable from ground with the aid of an operating stick.

a) Insulators used in the DO fuses shall be of the solid core post type, made of porcelain to withstand a mechanical force of 2kN (minimum).

b) Terminations shall be suitable for connection of compression terminal lugs.

The fuse element of the drop-out fuse unit shall be totally enclosed by a fuse holder, to protect it from the atmosphere. Specified electrical characteristics of the fuse units shall conform to IEC 282-2 and shall be:

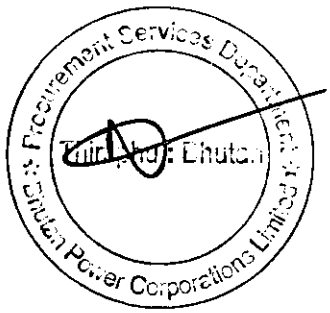
Sl. No	Parameters	33 kV	11 kV
1	Rated current of unit	200A	100A
2	Rated load current breaking capacity of Fuse	6A	20A
3	Dry impulse withstand voltage *	165 kVp	70 kVp
4	Power frequency withstand voltage *	80 kV	32kV
5	Rated breaking capacity	10kA	10kA

* Across the isolating distance of the fuse base

Altitude correction should be taken in to account when altitude exceeds 1000 meters

The DO fuse shall be capable of opening on transformer no load current. The rated current of the fuse link shall be as stated in the Schedules and each fuse link shall suit a common fuse base. The fuse links shall have the following time current characteristics, generally in accordance with IEC 60282-2 Class T.

The DO fuse will be mounted vertically on two (2) horizontal steel channels (ISMC 75) at a double-pole structure of pole mounted distribution substation and the following shall be the scope of supply.



a) 11kV Drop out fuse consisting of the following:

1 Two numbers of solid core post type insulators, creepage distance of 320 mm, IR value of 2500 Mega ohms. Post insulator shall be able to withstand a mechanical force of 2 kN (minimum).
2 Fuse carrier bakelite tube with heavily tinned non-ferrous metal parts and spring loaded with fuse element.
3 GI channel ISMC 75 – length as per manufacturer design.
4 GI flat size 75 x 10 mm. – length as per manufacturer design.
5 3 sets GI nuts and bolts full threaded size of 16mm and length of 125 mm long.

b) 33kV Drop Out fuse consisting of the followings:

1 Two numbers of solid core post type insulators, creepage distance of 900 mm with cantilever strength of 4 kN. Post insulator shall be able to withstand a mechanical force of 3 kN (minimum).
2 The set should contain 1 unit post insulators per phase complete with fuse carrier bakelite tube with heavily tinned nonferrous metal parts and spring loaded with fuse element.
3 GI channel ISMC 100 – length as per manufacturer design.
4 GI flat size 75 x 10 mm. – length as per manufacturer design.
5 3 sets GI nuts and bolts full threaded size of 16mm and length of 125 mm long.

Air Break Switches

Air break switches conforming to IEC 62271-102 and IEC 62271-103 are required to sectionalize 33kV and 11kV feeders. The switches shall be air break, three poles, single throw, vertical switches fitted with load break heads and supplied complete with galvanized steel mounting brackets to form one switch and operating rods.

They shall have the following characteristics:

Sl. No.	Parameters	11kV	33kV
1	Rated normal current (A)	630	630
2	Rated 3 sec. withstand current (rms) (KA)	16	16
3a	Rated line-charging breaking current (A)	1	2
3b	Rated Cable Charging Breaking Current (A)	10	20
4	BIL (kV)		
a	Rated Power Frequency withstand	28	70
b	Rated impulse withstand	75	170

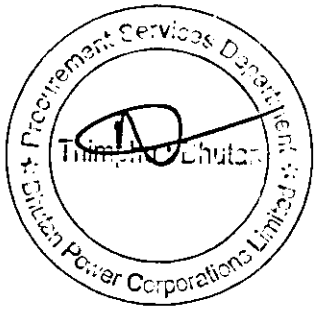
The switches shall be outdoor use and supplied with porcelain insulators. Parts carrying heavy current shall be made of copper. All steel parts shall be hot dipped galvanized.

No ferrous materials shall be used above the insulator caps. All joints and bearings shall operate effectively without lubrication. Terminations shall be suitable for connection of compression terminal lugs and supplied with nuts, bolts and washers for the lugs.

Air break switches shall be operated from ground level by means of rods and levers, suitable for pole height of maximum 8 (eight) metre with cross arms to be fitted on double pole configuration for 11kV and 33kV distribution lines. An "off/on" indicator shall be provided. A reliable locking device shall be provided to enable the control handle to be locked in either the open or closed position. The operating handle shall have provision for earthing. The cable clamp shall be suitable for 40-150 mm^2 cable and the down rod shall be approximately 25NB steel pipe. Bidder shall submit with his Bid a typical arrangement drawing of ABS in vertical position and the operating mechanism (including such as operating rod, hand, etc.) to be installed in double pole structure. The centre-to-centre spacing between adjacent conductors (phase to phase) shall be not less than 800mm.

The air break switches will be mounted in vertical in a double-pole structure that will be provided by another supplier. The Supplier shall provide a suitable galvanized steel mounting base/bracket for each ABS, complete with bolts (M16), nuts and washers, to meet to mount on the double pole structure. The Supplier shall provide the information of the base/bracket of ABS to the supplier of double pole structure, via Purchaser.

Technical Specification for Lot No. 8A (Polymer Insulators with Fittings for Distribution Lines)



1.0 General Specification

1.1 Scope

This Specification covers the design, manufacture, testing and inspection, packing, shipping, delivery, and performance requirements of Insulators and its fittings.

Any departure from the provisions of this Specification shall be disclosed in the deviation sheet. This section covers the design, manufacture, testing, and delivery to site of polymer insulators and fittings as follows:

(i) Polymer Pin Insulators and Fittings

(ii) Polymer Strain Insulators and Fittings

(iii) Stay/Guy Insulator

1.2 Polymer Pin Insulators

Polymer Pin insulators shall be manufactured conforming to IEC 60815-3/IS 3134. The insulators shall have necks suitable for fastening conductors with tie wire or preformed fitting. Polymer pin insulators shall be such that it shall be suitable for using in lines with any of covered conductor of conductor sizes up to 150 sq.mm plus 3mm thickness of XLPE insulation and ACSR conductor sizes up to 150 mm^2. Insulators should thus be manufactured accordingly to fit with the above ranges of conductor sizes.

Polymer Pin insulators shall have the following minimum characteristics.

1.3 Minimum Characteristics of Polymer Pin Insulators

Characteristics	Unit	11 kV	33 kV
Applicable Standard		IEC 61109, IEC 60815-3/IS 3134	
Type of insulators		Composite	
Material of the insulator		Silicon rubber	
Material of the core rod		ECR grade Boron free	
Material of the housing & weather sheds		Silicon Rubber	
Material of the end fittings		Spheroidal graphite cast Iron (SGCI) with hot dip galvanised	
Sealing compound of the end fitting		Silicon based sealant	
Type of sheds		Aerodynamic with **alternating sheds**	
Diameter of FRP rod	mm	24	
Insulator Test Voltage			

Characteristics	Unit	11 kV	33 kV
Highest System Voltage	kV(RMS)	12	36
Visible Discharge Test	kV(RMS)	9	27
Wet 1 minute Power frequency withstand voltage	kV(RMS)	35	135
Impulse voltage withstand test	kV peak	75	170
Nominal creepage distance	mm	25mm/kV	25mm/kV
Mechanical Load			
Cantilever strength (Minimum failing load)	kN	10	10
Color	-	Grey	

Note:

The above parameters are the values for 1000m altitude and shall be corrected based on the elevation mentioned in Service conditions shall be designed.

1.4 DIMENSIONAL TOLERANCE OF COMPOSITE INSULATORS:

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109:

± (0.04d+1.5) mm when d<300 mm,
± (0.025d+6) mm when d>300 mm,

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be, However, no negative tolerance shall be applicable to creepage distance.

A maximum tolerance of ±50mm shall be allowed on all dimensions for which specific tolerances are not given on the insulator drawing.

1.5 CORONA AND RI PERFORMANCE:

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

1.6 DESIGN AND CONSTRUCTION:

The Composite Pin Insulator shall have a core, housing & weather shed of insulating material and steel/aluminium alloy hardware components for attaching it to the support/conductor.

a) Core:

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

b) Housing (Sheath):

The FRP rod shall be covered by a seamless sheath of a silicone electrometric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cover the core. The elastomeric housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109with latest amendments.

c) Weather sheds:

The composite polymer weather sheds made of a silicone elastomeric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. It should protect the FRP rod against environmental influences, external pollution and humidity. The weather sheds should have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

d) End Fittings:

End fittings transmit the mechanical load to the core. They shall be made of spheroidal graphite cast Iron, malleable cast iron or forged steel or aluminium alloy. They shall be connected to the rod by means of a controlled compression technique. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibres or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone electrometric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide

superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof.

The end fittings of Insulators i.e. the installation outline of the top and bottom shall be of same size with porcelain pin type. The details of end fittings for fixing the same on the channel are given below:-

1.7 Details of Pin-End Fittings for Fixing on the Channel

Sl#	Item	Length of end fittings to be fixed	Min. threaded portion of end fittings	Dia of rod
1	33 kV	150 mm	100 mm	24 mm
2	11 kV	150 mm	100 mm	24 mm

Upper end fittings shall be suitable to hold AAAC Covered (49.5 sq.mm&111 sq.mm), ACSR WOLF, ACSR DOG and ACSR RABBIT for 33kV systems. The size of the fitting at the top shall be in such a way that conductor could be bound firmly so that it may not slip from the groove while in service even under adverse conditions.

1.8 WORKMANSHIP:

All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.

The design of the Insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

The core shall be sound and free of cracks and voids that may adversely affect the Insulators.

Weather sheds shall be uniform in quality. They shall be clean, sound and smooth and shall be free from defects and excessive flashing at parting lines.

End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress. All surfaces of the metal parts shall be perfectly smooth without projecting points or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc and shall be in accordance with the requirement of IS: 4759. The zinc used for galvanizing shall be of purity 99.5% as per IS: 4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters.

1.9 EQUIPMENT MARKING:

Each insulator unit shall be legibly and indelibly marked with the following details as per IEC-61109:

- Month &Year of manufacture.
- Min. failing toad/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
- Manufacturer's name/Trade mark.

1.10 BID DRAWINGS:

The Bidder shall furnish full description and illustration of the material offered.

The Bidder shall furnish along with the bid the outline drawing (2 copies) of each insulator unit including a cross sectional view of the pin insulator unit. The drawing shall include but not be limited to the following information:

(a) Insulator diameter with manufacturing tolerances.
(b) Minimum creepage distance with positive tolerance.
(c) Protected creepage distance.
(d) Unit mechanical and electrical characteristics
(e) Weight of composite insulator unit.
(f) Materials
(g) Identification mark
(h) Manufacture's catalogue number

1.11 TESTS AND STANDARDS:

Insulators offered shall be manufactured with the same configuration & raw materials as used in the Insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. The design & type test reports submitted shall not be more than 5 years as on the date of bid opening. In case the tests reports are of the tests conducted earlier than five years as on the date of bid opening, the contractor shall repeat these tests at no extra costs to the Purchaser. Inspection and tests on the equipment offered shall be carried out in the presence of

Procurement Department, Bhutan Power Corporation Limited, Thimphu, Bhutan

Purchaser's representative unless inspection waiver has been given to the Supplier. Testing and Inspection shall be carried out as per relevant Standards and Codes.

1.12 PACKING:

All Insulators shall be packed in strong wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 kg to avoid handling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

2.1 Polymer Disc Insulators

Composite strain insulators to IEC 61109 and IEC 60471 complete with ball and socket fittings conforming to IEC 60305 and IEC 60120 shall be supplied. The polymer strain insulators shall withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.

2.2 Minimum Characteristics applied to Polymer Disc Insulators

Characteristics	Unit	11 kV	33 kV
Applicable Standard		IEC 61109-2008 and IS 731	
Type of insulators		Composite	
Material of the insulator		Silicon rubber	
Material of the core rod		ECR grade Boron free	
Material of the housing & weather sheds		Silicon Rubber	
Material of the end fittings		spheroidal graphite cast Iron (SGCI) with hot dip galvanised	
Sealing compound of the end fitting		Silicon based sealant	

Type of sheds		Aerodynamic with **alternating sheds**	
Diameter of FRP rod	mm	24	
Insulator Test Voltage			
Highest System Voltage	kV(RMS)	12	36
Visible Discharge Test	kV(RMS)	9	27
Wet-Power frequency withstand	kV(RMS)	28	70
Minimum power frequency flashover voltage • Dry • Wet	kV	110 70	140 95
Power frequency puncture withstand test	kV	145	185
Impulse voltage withstand test	kV peak	75	170
Nominal creepage distance	mm	25mm/kV	25mm/kV
Mechanical Load			
Cantilever strength (Minimum failing load)	kN	70	70
Color	-	Grey	

The locking devices for the ball and socket couplings shall comply with IEC 60372 recommendations.

The clip shall be W-type and of phosphor bronze material. Retaining pins or locking devices for the insulator units shall be of phosphor bronze, supplied in the hard condition. The pins and locking devices shall be such that, when set under any condition of handling or service, nothing but extreme deformation shall allow separation of the insulator units or fittings or shall cause any risk of any retaining pins or locking devices being accidentally displaced.

2.3 Fittings and Accessories for Polymer Disc Insulator

The Supplier shall be responsible for design and supply of a complete set of strain insulator assemblies (fittings and accessories) to suit for the coupling with the following parts:

(i) Cross arm channel on double pole structure to be provided by another Supplier
(ii) Helical (preformed) dead end termination to be provided by another Supplier.

The supplier shall provide the strain insulator with complete set of assemblies, including a cross arm strap, a ball-eye, a socket-thimble, necessary GI bolts 175 mm long with half threaded and end locking clips, nuts, flat and spring washers.

The socket-thimbles shall be of aluminium alloy and suitable for range of size of preformed dead-end terminations. The socket-thimble shall be supplied with a hot-dip galvanised hexagon cross-section cotter pin fitted with a humpback stainless steel split pin. For

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coupling between the clevis-thimble and the ball of insulator, a socket-eye shall be provided.

Bidder is required to provide the assembly drawing(s) for strain insulator with the above assembly.

2.4 Insulator Components of Polymer Stain Insulators

Polymeric stain insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:

(a) Core- the internal insulating part

(b) Housing- the external insulating part

(c) Metal end fittings.

a) <u>Core</u>

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

b) <u>Housing</u>

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments

c) Weathersheds

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. It should protect the FRP rod against environmental influences, external pollution and humidity. The

weather sheds should have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

d) Metal End Fittings

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be suitable for tongue & clevis hard wares of respective specified mechanical load and shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of Insulators shall be in accordance with the standard dimensions stated in IEC 60120.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The core shall be sound and free of cracks and voids that may adversely affect the insulators.

Under-surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical in shape without appreciable warping. The wire grooves of pin insulators shall be formed to provide a firm support for the conductor and shall permit the making of a secure tie.

Insulators shall be designed to avoid excessive concentration of electrical stresses in any section or across leakage surfaces. Design features which increase radio influence level shall be avoided.

All metal parts shall be made of good commercial grade malleable iron or open hearth or electric furnace steel, hot dip galvanised conforming to relevant standards.

3.1 Stay/Guy Insulators

Guy insulators shall conform to IS 5300. The insulator shall be suitable for 7/8 SWG guy wire preformed terminations.

The common minimum characteristics shall apply to all guy insulators for both 11kV and 33kV distribution lines as shown below.

3.2 Minimum Characteristics of the stay/guy Insulators

Characteristics	Unit	33 kV & 11 kV	415/240
Minimum failing load	kN	88	44
Creepage Distance	mm	57	41
Dry one minute power frequency withstand voltage	kV(rms)	27	18
Wet one minute power frequency withstand voltage	kV(rms)	13	8
Length	mm	140	90
Diameter	mm	85	65
Cable hole dia	mm	25	16

4. Identification Marks

Each insulator unit shall be marked with the name or trade mark of the manufacturer and the year of manufacture in accordance with IEC 61109, and means to ensure a system of traceability for each of the component parts. In addition, each insulator unit shall be marked with the specified mechanical failing load in conformity with IEC 61109.

The design of identification marks on insulators shall be subject to approval by the Purchaser.

5. Inspections and Tests

5.1 General

All tests shall be carried out in accordance with the relevant IEC Standards and other applicable Standards.

The cost for the tests shall be included in the prices estimated in the Price Schedules of Goods.

The Bidder shall submit type test reports with the bid. In case the type test reports submitted with Bid are of the tests conducted earlier than five years as on the date of bid opening, the Supplier shall repeat these type tests at no extra costs to the Purchaser.

5.2 Routine Tests

The following items shall be carried out according to the IEC standards:

- Visual examination
- Mechanical routine test
- Electrical routine test

5.3 Sample Tests

Insulators for the sample tests shall be selected at random from the batch. The number of test pieces shall be P, or the nearest whole number greater than P given by the following formulae.

P subject to agreement when $n < 500$

$P = 4 + (1.5\ n / 1{,}000)$, when $500 < n < 20{,}000$

$P = 19 + (0.75\ n / 1{,}000)$, when $n > 20{,}000$

where, n = number of insulators in the batch

After having withstood the routine test stated above, the test pieces of insulators shall be subject to the following tests.

(i) Verification of dimensions

(ii) Temperature cycle test

(iii) Electromechanical failing load test

(iv) Puncture test

(v) Porosity test

(vi) Galvanizing test (mass of zinc per unit surface)

If only one insulator or metal part fails to comply with any of the sample test, a new quantity equal to twice the quantity originally subjected to that test shall be subject to re-testing.

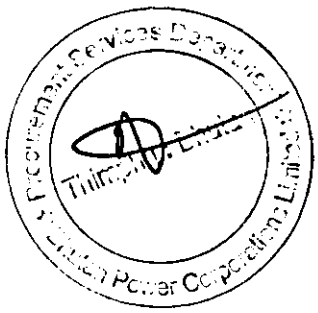
If two or more insulators or metal parts fail to comply with any of the sample test, or if any failure occurs on insulators or metal parts subjected to re-testing, the complete batch will not be accepted.

5.4 Inspection by Purchaser

Inspection and tests on all the Goods offered shall be carried out in the presence of Purchaser's representative unless inspection waiver has been given to the Supplier. The inspection shall be carried out as per the test procedure that has been approved by the Purchaser. The Supplier shall assist the work of the Purchaser's inspector by providing copies of all relevant Standards and test procedures, and allowing the inspector full use of the necessary tapes, measures and laboratory equipment, together with ample space and assistance in the handling of Goods for inspection.

The Supplier shall submit all final test and inspection reports to Purchaser's representative (inspector) during his stay at the workshop for the inspection. The inspector shall issue a "Dispatch Clearance" to the Supplier when the tests and inspection has successfully completed in compliance with the Technical Specifications.

Technical Specification for Lot No. 8B (Polymer Insulators for Transmission Lines)



1.0 Technical Specification for Polymer Insulators for Transmission Lines

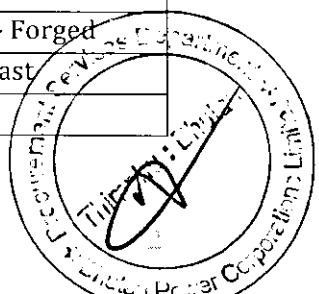
1.1 Scope

This Specification covers the design, manufacture, testing and inspection, packing, shipping, delivery, and performance requirements of Insulators and its fittings for transmission lines.

Any departure from the provisions of this Specification shall be disclosed in the deviation sheet. This section covers the design, manufacture, testing, and delivery to site of polymer insulators and fittings for transmission lines.

Table 1: Specification for 66 kV, 90 KN Composite Long Rod Polymer Insulators for Transmission Lines

Sl. No.	DESCRIPTION	UNIT	66 kV, 90 KN Polymer Insulators
1	Size and Designation of Ball & Socket assembly	mm	16
2	Core diameter	mm	18
3	Tolerance on Core Diameter	±mm	0.5
4	Nominal length (Section Length)	mm	870
5	Tolerance on Nominal Length	±mm	28
6	Dry Arcing distance	mm	738
7	Shed Profile		Aerodynamic
8	Shed profile(Regular alt ernating)		Alternate
9	Shed diameter-Big/Small	mm	140/110
10	Tolerance on Shed Diameter	mm	As per IEC
11	Minimum Creepage distance	mm	2248
12	Tolerance on Creepage distance	mm	No -ve Tolerance
13	Guaranteed mechanical strength	KN	90
14	Routine mechanical load	KN	45
15	System Nominal Voltage	kV	66
16	Highest System Voltage	kV	72.5
17	System Frequency	Hz	50
18	Material		
	a) FRP Rod		ECR Grade Boron Free
	b) Sheds w it h % content s of silicon e		30%
	c) Housing		Silicone Rubber
	d) End Fittings - Ball	Ball	Gr. EN8 D - Forged
	e) End Fittings - Socket	Socket	SG Iron - Cast
19	Minimum thickness of sheath covering over the	mm	3



Sl. No.	DESCRIPTION	UNIT	66 kV, 90 KN Polymer Insulators
	core		
20	Power frequency Withstand voltage (Wet)/ (Dry)	kV(rms)	140 / 160
21	Impulse Withstand Voltage (Dry)		
	Positive	kV(Peak)	350
	Negative	kV(Peak)	350
22	Galvanising - Minimum mass of zinc coating	gms/ sq. mt.	620
23	Packing		Corrugated tube
24	Standard according to which the insulator shall be manufactured and tested	I EC	61109

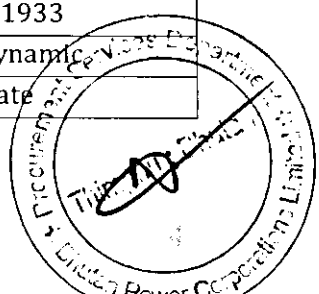
Table 2: Technical Specification for 132 kV, 90 KN Composite Long Rod Polymer Insulators

SL. No.	DESCRIPTION	Unit	132 kV, 90 KN Polymer Insulator
1	Size and Designation of Ball & Socket assembly	mm	16
2	Core diameter	mm	20
3	Tolerance on Core Diameter	±mm	0.5
4	Nominal length (Section Length)	mm	1450
5	Tolerance on Nominal Length	±mm	42
6	Dry Arcing distance	mm	1300
7	Shed Profile		Aerodynamic
8	Shed profile(Regular alternating)		Alternate
9	Shed diameter -Big/ Small	mm	139/108
10	Tolerance on Shed Diameter	mm	As per IEC
11	Minimum Creepage distance	mm	4495
12	Tolerance on Creepage distance	mm	No -ve Tolerance
13	Guaranteed mechanical strength	KN	90
14	Routine mechanical load	KN	45
15	System Nominal Voltage	kV	132
16	Highest System Voltage	kV	145
17	System Frequency	Hz	50

SL. No.	DESCRIPTION	Unit	132 kV, 90 KN Polymer Insulator
18	**Material**		
	a) FRP Rod		ECR Grade Boron Free
	b) Sheds with% contents of silicone		30%
	c) Housing		Silicone Rubber
	d) End Fittings - Ball	Ball	Gr. EN8 D - Forged
	e) End Fittings - Socket	Socket	SG Iron - Cast
	f) Grading Rings		-
19	Minimum thickness of sheath covering over the core	mm	3
20	Power frequency Withstand volt age (Wet/ Dry)	kV(rms)	275 / 285
21	Impulse Withstand Voltage (Dry)		
	Positive	kV(Peak)	650
	Negative	kV(Peak)	650
22	Galvanising - Minimum mass of zinc coating	gms/ sq . mt.	620
23	Packing		Corrugated tube
24	Standard according to which the insulator shall be manufactured and tested	IEC	61109

Table 3: Specification for 220 kV, 120 KN Composite Long Rod Polymer Insulators for Transmission Lines

SL. No.	DESCRIPTION	UNIT	220 kV, 120 KN Polymer Insulator
1	Size and Designation of Ball & Socket assembly	*mm*	20
2	Core diameter	mm	20
3	Tolerance on Core Diameter	*mm	0.5
4	Nominal length (Section Length)	mm	2175
5	Tolerance on Nominal Length		50
6	Dry Arcing distance		1933
7	Shed Profile		Aerodynamic
8	Shed profile(Regular alternating)		Alternate



SL. No.	DESCRIPTION	UNIT	220 kV, 120 KN Polymer Insulator
9	Shed diameter-Big/Small	mm	139/ 108
10	Tolerance on Shed Diameter	mm	As per IEC
11	Minimum Creepage distance	mm	7595
12	Tolerance on Creepage distance	mm	No -ve Tolerance
13	Guaranteed mechanical strength	KN	120
14	Routine mechanical load	KN	60
15	System Nominal Voltage	kV	220
16	Highest System Voltage	kV	245
17	System Frequency	Hz	50
18	Material		
	a) FRP Rod		ECR Grade Boron Free
	b) Sheds with % contents of silicone		30%
	c) Housing		Silicone Rubber
	d) End Fittings - Ball	Ball	Gr. EN8 D - Forged
	e) End Fittings - Socket	Socket	SG Iron - Cast
	f) Grading Rings		Alluminium Alloy
19	Minimum thickness of sheath covering over the core	mm	3
20	Power frequency Withstand voltage (Wet/Dry)	kV(rms)	460 / 480
21	Impulse Withstand Volt age (Dry)		
	Positive	kV(Peak)	1050
	Negative	kV(Peak)	1050
22	Galvanising - Minimum mass of zinc coating	gms/sq. mt.	620
23	Packing		Corrugated tube
24	Standard according to which the insulator shall be manufactured and tested	IEC	61109

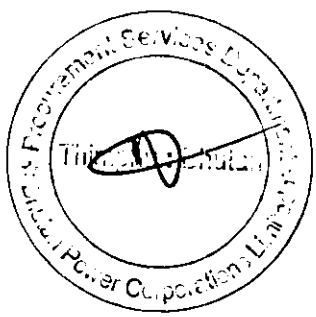
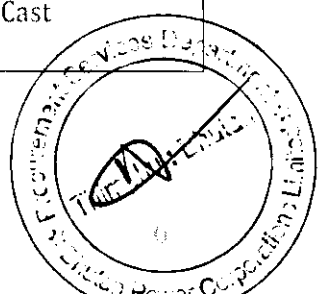
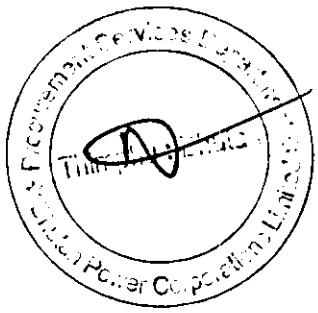


Table 4: Specification for 400 kV, 160 KN Composite Long Rod Polymer Insulators for Transmission Lines

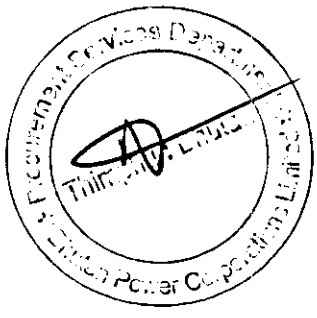
SL. No.	DESCRIPTION	UNIT	400 kV, 160 kN Polymer Insulator
1	Size and Designation of Ball & Socket assembly	mm	20
2	Core diameter	mm	24
3	Tolerance on Core Diameter	±mm	0.5
4	Nominal length (Section Length)	mm	3910
5	Tolerance on Nominal length	±mm	50
6	Dry Arcing distance	mm	3677
7	Shed Profile		Aerodynamic
8	Shed profile(Regular alternating)		Alternate
9	Shed diameter-Big/ Small	mm	132/90
10	Tolerance on Shed Diameter	mm	As per IEC
11	Minimum Creepage distance	mm	13020
12	Tolerance on Creepage distance	mm	No -ve Tolerance
13	Guaranteed mechanical strength	KN	160
14	Routine mechanical load	KN	80
15	System Nominal Volt age	kV	400
16	Highest System Voltage	kV	420
17	System Frequency	Hz	50
18	**Material**		
	a) FRP Rod		ECR Grade Boron Free
	b) Sheds with % contents of silicone		30%
	c) Housing		Silicone Rubber
	d) End Fit tin gs - Ball	Ball	Gr. EN8 D - Forged
	e) End Fittings - Socket	Socket	SG Iron - Cast



SL. No.	DESCRIPTION	UNIT	400 kV, 160 kN Polymer Insulator
	f) Grading Rings		Alluminium Alloy
19	Minimum thickness of sheath covering over the core	mm	3
20	Power frequency Withstand voltage (W et/ Dry)	kV(rms)	680 / 700
21	Impulse Wit hst and Vo lt age (Dry)		
	Posit ive	kV(Peak)	1550
	Negativ e	kV(Peak)	1550
22	Galvanising - M inim um mass of zin c coating	gms/ sq. m t.	620
23	Packing		Corrugated tube
24	Standard according to which the insulator shall be manufactured and tested	IEC	61109



Technical Specification for Lot No. 9A (Lightning Arrestor)



1.0 General Specification for Lightning Arrestors

1.1 Scope

This Specification covers the design, manufacture, testing and inspection, packing, shipping, delivery, and performance requirements of Insulators and its fittings for transmission lines.

Any departure from the provisions of this Specification shall be disclosed in the deviation sheet. This section covers the design, manufacture, testing, and delivery to site of polymer insulators and fittings for transmission lines.

1.2 The lightning arrestors shall be of the metal oxide, gapless, single pole type, suitable for outdoor use on a three-phase 50 Hz system and shall have the following parameters:

Table 1: Specification of Surge Arrestors

Parameter	**33 kV**	**11 kV**
Applicable standard	IS 3070, IEC 60099-4	
Rated Voltage (rms)	30 kV	9 kV
Nominal discharge current (kA)	10 kA	10 kA
MCOV	24.4 kV	7.65 kV
Maximum Residual Voltages for:		
Steep Current impulse (1/20 micro sec.)	85 kV	26.5 kV
Lightning Impulse protection level (8/20 micro sec.)	71.8 kV	21.7 kV
Switching impulse protection level (30/60 micro sec.)	60 kV	18 kV
Type of Housing Insulator	Polymer with alternating sheds	
Moisture sealing system	Housing directly molded onto the arrester. Housing pressed on arrester with caps at the end not acceptable.	
Colour	Grey/Brown	

Note: Ground and line lead of the arrester is important. The lead voltage can contribute as much as the arrester protective level for long length. Therefore, arrester lead length shall be as short and straight as possible.

BIL value should be corrected above 1000 meters.

1.2 Arrester Fittings

Surge arresters will be connected between phase and earth to protect distribution transformers and switchgear. It shall be complete with the following:

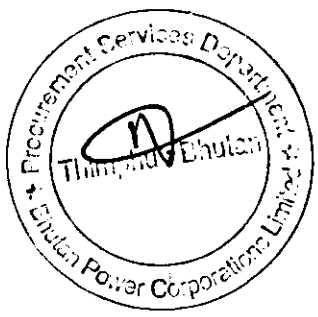
- Arrester terminal shall be nut and bolt (M12), suitable for connecting lugs with 14 mm dia hole or clamp type to accommodate standard conductor sizes used by BPC.
- Earth connection lead or earthing clamp terminals.
- The surge arresters shall be provided with mounting brackets complete with bolts, nuts and washers, suitable for mounting either vertically or horizontally on cross-arm channel (ISMC 75x40) bearing 18 mm dia holes.
- Disconnect or device for disconnecting it from the system in the event of arrester failure to prevent a persistent fault in the system and it shall give a visible indication when the arrester has failed. The arrester disconnect or shall be tested as per IEC 60099-4.
- Over pressure relief device shall be provided for relieving internal pressure in an arrester and preventing explosive shattering of the housing following prolonged passage of flow current or internal flashover of the arrester.

1.3 Consideration at High Altitude

- If low altitude designed arrester is used at high altitude, possibility exists that the internal pressure of the arrester will be sufficiently high to cause a leak in the seal arrester allowing moisture to enter it causing failure. Therefore due attention must be given to moisture sealing system employed by the manufacturer.

- A second potential problem exists with the new metal oxide arresters in which the overall length of the housing is decreased substantially. Attention must be given to assure that an adequate margin exists between the arrester protective characteristics and the external flashover of the housing at high altitude.

Technical Specification for Lot No. 9B (Surge Monitor)



1.0 Surge Monitors

Scope

This Specification covers the design, manufacture, testing and inspection, packing, shipping, delivery, and performance requirements of Surge Monitors.

Any departure from the provisions of this Specification shall be disclosed in the deviation sheet. This section covers the design, manufacture, testing, and delivery to site of Surge Arrestors

Table 1: Specification for Surge Monitor

Sl. No.	Description	Requirement
1	Type	Non-Reset, Cyclometric counter
2	Sensitivity of Surge Counter (min. current at which the Counter operates)	I00A (8/20μsec wave)
3	Nominal Discharge Current	10 kA
4	Max. Current to be withstood by the Surge Monitor	100kA
5	Counter operation	One count per Surge
Operation of Current Meter		
6	Safe Leakage Current Indication	0 to 2 mA (Green Band)
7	Indication of deterioration of Surge Arrester	2 to 5 mA (Red Band)
8	Net. Weight	3.5 kgs. (approx.)