



Bhutan Power Corporation Limited

(An ISO 9001:2015, ISO 14001:2015 & OHSAS 18001:2007 Certified Company) Registered Office, Thimphu Procurement Services Department Thimphu: Bhutan



August 25, 2020

BPC/PSD/2021 Materials/2020/10/

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Subject: <u>Addendum No. I</u>

Tender Title: Supply and Delivery of Electrical line and substation materials (Package B)

Reference: <u>BPC/PSD/2021 Materials/2020/10 dated August 15, 2020</u>

Dear Sir(s),

This is with reference to above mentioned tender whereby PSD, BPC would like to issue an addendum no. I as given below:

- 1. The Technical Specifications of the lots are attached here as *Annexure-1*. Kindly refer the technical specifications of the lots.
- 2. The additional GTP forms for the items under Lot 2- Switching Equipment is attached here as Annexure-II. Kindly refer the additional GTP forms to be filled up by the bidders.
- 3. The technical drawing samples for Switching equipment (lot 2), Lightning arrestor (lot 3) and Earthing Equipment (lot 6) are attached here as Annexure-III for your reference. Kindly refer the sample drawings of the mentioned lots.
- 4. The price schedule for Distribution Transformer (lot-4) has been amended. Kindly refer the revised price schedule attached here as Annexure-IV.

However, due to the above inclusion and additional information, no time extension shall be granted and the submission date and time shall remain the same.

Thanking you.

Yours sincerely,

(Nim Dorji) General Manager

Annexure-I Lot 1: Distribution Board

1.0 Scope:

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

2.0 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. Nothing in this drawing shall be responsibility. Supply items which are brought out by manufacturers shall be procured from the approved manufacturers acceptable to the Procurement Services Department, BPC.

3.0 Construction Features:

- 3.1 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.
- 3.2 The Distribution pillar shall be provided with hinged doors openable from the centre. It should be also provided with IEC standard type lock and pad locking arrangement.
- 3.3 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.
- 3.4 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.
- 3.5 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.
- 3.6 The external earthing terminal with M1O and 19 mm x 6 mm Aluminum alloy of E91E grade earthing strip inside should be provided.

4.0 Painting:

- 4.1 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

- 4.2 After prepping, the equipment shall be dried at 250 degrees for 5-1/2 minutes.
- 4.3 Epoxy polyester hybrid power plant shall be electrostatically applied.
- 4.4 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.
- 4.5 After curing, the paint finish is inert and no volatile emissions are present. There are no fugitive (stray) emissions in the finished product.
- 4.6 Gloss: 50 60 degrees Impact Resistance: 18.07 Nm Flexibility: 180 degrees, ¹/₄ "mandrel Pencil hardness: 2H Cross hatch adhesion: 100% Salt spray: 200 hours minimum Humidity resistance: 200 hours minimum Micron thickness: 80 microns

5 Main Busbar:

- 5.1 Main busbar shall be of Aluminum alloy of grade E91E, and as specified in drawing and conforming to relevant standard IS: 5082.
- 5.2 Busbar shall be located in horizontal formation but with gradual gradient as indicated in drawing.
- 5.3 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.
- 5.4 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.
- 5.5 Busbar should not be painted and all performance characteristics specified shall be obtained with unpainted busbars.
- 6.0 Fuses
- 6.1 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.

7.0 Interior Lighting

7.1 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.

7.2 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.

8.0 Labels and Danger Plate:

8.1 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.

9.0 Submission of Test Certificate & Drawings

The supplier shall provide the type test certificates for the boxes done within Five (5) years from the reputed testing laboratory

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

Lot 2: Switching Equipment

1.0 Air Break Switches

Load Break Switch / Air Break switch is a manually operated switch used for breaking and making the circuit on load without damage to the switching equipment. This switch is supplied fitted with load break arc interrupters to allow the switch to be used to interrupt load currents in accordance with IEC 60265-1. Air break switches are generally used outdoor for circuits of medium capacity such as long lines supplying a village/industrial /commercial loads from main line/feeder for isolation and switching.

Parameter	33 kV	11 kV
Applicable standard	IEC 60271-102 and IEC 60265-1	
Rated normal current (A)	630	630
Rated 1 sec withstand current (kA)	16	16
Rated peak withstand current (kA)	40	40
Rated power frequency withstand voltage		
1. Across open contacts (kV)	80	32
2. To Earth and Between poles (kV)	70	28
Rated impulse withstand voltage		
1. Across open contacts (kV)	195	85
2. To Earth and Between poles (kV)	170	75

Standard Specification for Medium Voltage Load Break Switches.

2.0 MV Drop-Out Fuses

Medium voltage drop out fuses are needed to protect distribution transformers and also to protect lightly loaded spur lines. Fuse bases shall conform to the requirements of table shown below. The medium voltage fuse barrel carrying fuse links shall be of the disconnecting type suitable for opening, closing and removal when energised using an insulated operating stick.

Standard Specification for Medium Voltage Drop Out Fuse Bases

Parameter	33 kV	11 kV
Applicable standard	IEC 60282-2,IS 9385 I-III	
Туре	Explusion drop out type for outdoor	
		use
Rated current of the fuse base (A)	100	100
Rated load breaking capacity (A)	6	20
Insulation level:		
Dry Impulse withstand (1.2 kV/50 μ s) voltage (positive		
& negative polarity) (peak)		
• Across the isolating distance of the fuse base kV	195	85

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Parameter	33 kV	11 kV
• To earth and between poles kV	170	75
 Wet 1 min. Power frequency withstand voltage (rms.) Across the isolating distance of the fuse base kV. To earth and between poles kV 	80 70	32 28
Rated short time breaking capacity (kA)	8	10
Minimum Creepage Distance	900	300
Mounting Arrangement	Vertical Mountin	ng on two Channels

Note: When fuses are require to be used above 1000 m, the rated insulation levels to be specified should be determined by appropriate correction factors.

Each cutout unit shall be supplied complete with connection terminals suitable for conductors ranging in size from 16 mm² to 120 mm².

Lot 3: Lightning Arrestor

The surge arresters 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:

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	71.8 kV	21.7 kV
micro sec.)		
Switching impulse protection level	60 kV	18 kV
(30/60 micro sec.)		
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	

 Table 1: Specification of Surge Arrestors

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.

1.0 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.
- Disconnector 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 disconnector 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.

2.0 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.

Lot 4: Distribution Transformer

1. Scope

This Specification covers the design, manufacture, testing and inspection, packing, shipping, delivery, and performance requirements of indoor/outdoor 33 kV and 11kV three phase and single phase (two wires) distribution transformers.

Any departure from the provisions of this Specification shall be disclosed in the Schedule of Non-Compliance of this document.

2. Transformer Weights and Special Bracing of Windings

a) Transformer winding shall be so braced / fitted internally to protect the windings against excessive movement and vibration during transportation and particularly during hand cartage to site.

3. Standards

The transformers shall conform to the latest version of the following IEC Standards:

- IEC 60076 Power Transformers.
- IEC 60137 Insulating bushings for alternating voltages above 1000 V.
- IEC 60296 Specification for unused mineral insulating oils for transformers and switchgear.
- IEC 60354 Loading guide for oil-immersed power transformers.
- IEC 60529 Degrees of protection provided by enclosures (IP Code).
- IEC/TR 60616 Terminal and tapping markings for power transformers.

4. Packing

Transformers shall be crated at the manufacturer's works in a manner entirely suitable for international transport and delivery to the Purchaser's warehouse. Bushings and other parts liable to damage shall be additionally protected. The transformers shall be securely bolted to pallets suitable for handling by forklift. In addition the normal lifting eyes shall be accessible with the crating and pallet in place for handling by slings from a crane.

Each crate shall be clearly marked with the rating and voltage of the transformer, and the total transport weight.

5. Losses

The fixed (iron) and running (copper) losses shall be as low as possible, consistent with reliability and economical use of materials. The supplier shall provide the guaranteed values of losses in the Schedule of Technical Particulars enclosed with the Bid document.

Maximum losses of the transformer should be as follows:

		Max losses	
SL#	DESCRIPTION	No Load Losses	Load Losses
(A)	11/0.415 kV System		
1	500 kVA Transformer	0.850	5.5
2	250 kVA Transformer	0.450	3.0
3	125 kVA Transformer	0.300	1.7
4	63 kVA Transformer	0.175	1.3
5	25 kVA Transformer	0.07	0.425
(B) 33/0.415 kV System			
1	500 kVA Transformer	0.850	5.50
2	250 kVA Transformer	0.55	3.50
3	125 kVA Transformer	0.30	1.70
4	63 kVA Transformer	0.175	1.30
5	25 kVA Transformer	0.125	0.425
(C)	33/0.240 kV System		
1	25 kVA Transformer	0.125	0.425
(D)	11/0.240 kV System		
1	16 kVA Transformer	0.075	0.350

Bidders are to design the transformer based on the above losses only and no tolerance will be permitted beyond the above values. Those bidders who do not meet the above losses will be rejected.

6. Quality Assurance

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

7. TECHNICAL SPECIFICATIONS

7.1 General

This specification represents the minimum requirements for the works. The Supplier shall provide equipment, which meets or exceeds these minimum requirements. These items are being sought as additions to existing networks; it is essential to maintain compatibility with existing hardware and line design, as well as with established local work practices and methods.

7.2 Tests and Test Certificates

All tests shall be carried out in accordance with IEC 76; routine tests, type tests, if certificates unavailable, as well as any agreed special tests. A satisfactory service history of approximately 5 years is preferred, for all plant items.

7.3 Technical Parameters

Ratings: The distribution transformers shall have the following ratings:

Three Phase: 11 kV – 500 kVA. 33 kV – 250 & 500 kVA

Single Phase: 11 kV – 16 & 25 kVA 33 kV – 25 kVA

7.4 Operating Characteristics

In addition to the common technical requirements specified, the following minimum operating characteristics shall apply to all the distribution transformers covered in this Specification:

Parameter	Requirement
Applicable standard	IS 2026, IEC 60076
Туре	Oil filled / two winding
Winding material	Copper
Core Material	CRGO silicon steel
Cooling	Oil natural air natural (ONAN)
Altitude	2400 m
Terminations	
Primary	Outdoor Bushing or cable box ¹
Secondary	Outdoor Bushing or Cable box
Rated no load voltage	
Primary	33 kV or 11 kV
Secondary	415 V
% Impedance	
10kVA-24kVA (1 phase/3 phase)	3%
25 kVA-630 kVA (1 phase/3 phase)	4%
Vector group	Dyn11
Tap changer	
• Туре	Off load
• Range	+5% to -5%
• Step value	2.5%
Insulation Class (IEC-76)	A
Permissible Temperature rise	
Maximum winding temperature	55°C
• Max. Top oil temperature	50°C
Insulation levels	
Primary	170 kVp-70 kV/75 kVp-28 kV
Secondary	7500 Vp-3000 V

Min. Clearances between Bushing	
(Outdoor)	
• HV phase to phase/phase to earth	350/320 mm (33 kV), 280/140 mm (11 kV)
• LV phase to Phase/phase to earth	
	25/20 mm
Min. Clearances between Bushing (Indoor)	
• HV phase to phase/phase to earth	
• LV phase to Phase/phase to earth	350/222 mm (33 kV), 130/80 mm (11 kV)
	25/20 mm
H.T Bushings	
• 12 kV bushings	Conforms to I.S: 3347 Part III(Sec 1&2)
• 36 kV bushings	Conforms to I.S: 3347 Part V(sec 1&2)
Maximum allowable noise level	As per IEC 551

Note 1: Bushing for pole mount and cable for pad mount as per the specific requirement at site.

8. Construction

The transformers shall be double-wound, oil immersed, naturally cooled (ONAN), oil types either hermetically sealed, or conventional type with tank breathers.

The core shall be constructed from M4 grade cold rolled, non-ageing, grain oriented silicon sheet steel having maximum of 1.11watt/kg. The primary and secondary windings shall be constructed from super enamelled insulated high conductivity copper. All turns of windings shall be adequately supported top and bottom, to prevent movement. In cases where turns are spaced out, a suitable interturn packing shall be provided. The insulation between core and bolts and core and clamps shall withstand 2,000V for one minute.

No material which can be deleteriously affected by the action of oil under the operating conditions of the transformers shall be used in the transformers or leads or bushings.

9. Transformer Tank and Covers

The transformer tank and covers shall be fabricated from sheet steel and shall be of robust construction. All welds shall be made by the electric arc process. With the exception of radiator elements, all external joints shall be seam welded. Cooling radiators shall be of robust and simple construction.

All matching faces of joints to be made oil tight shall be finished with a smooth surface to ensure that the gasket material will make a satisfactory joint. Bolts shall be spaced at sufficiently close intervals to avoid buckling of either flange or covers and provide reasonably uniform compression of the gasket.

Each transformer shall be provided with a minimum of two closed lifting lugs. The minimum diameter of the hole or width of the slot shall be 25 mm. The two lifting lugs shall be so located that there will be a minimum clearance of 100 mm between the lifting chain and the nearest part of the bushings. Oil conservators are not mandatory, but the bidder must state whether his bid includes or

excludes oil conservators. Transformers, other than hermetically sealed types, shall be fitted with oil draining and oil filling gate valves, plus a breather. An oil level sight glass shall be fitted marking the cold oil level.

Transformers 160kVA and below will be mounted on pole platform structures with four 12.5 mm dia bolts spaced 400 mm centre-centre for transformers up to and including 25kVA and spaced 500 mm centre- centre for transformers above 25kVA capacity.

The transformer tank base shall be provided with two steel channels having 14mm dia. holes to allow bolting to pole platforms. The 2 holes on the same channel should be spaced 227 mm centre-centre for transformers up to and including 25kVA and spaced 242 mm centre- centre for transformers above 25kVA capacity.

10. Transformer Sealing

For sealed units, a satisfactory lid sealing gasket shall be provided on each of these transformers to maintain the seal at extremes of operating temperature. A cold oil level mark shall be provided inside each transformer marked C.O.L.

11. Internal and External Finish

Internal and external tank and radiator surfaces shall be thoroughly cleaned by shot blasting or be given an acid and phosphate dip treatment to remove rust and scale and to provide an adherent, moisture resistant coating. Due care shall be given to avoid over pickling, resulting in pitting or unduly heavy deposit of phosphate. This resultant coating shall provide a surface, which shall offer good paint adhesion and a resistance to corrosion. The interior surfaces of the tank and cover, or conservator; above the lowest oil level shall be given one coat of oil and acid resisting paint, after cleaning.

The exterior surfaces of the complete transformer shall, where appropriate, be protected by a paint system which shall be applied strictly in accordance with the paint manufacturer's instructions. The system shall consist of not less than two priming coats and two finishing coats of oil and weather resisting paint.

The total thickness of the paint shall be not less than 0.120 mm with a minimum total thickness of priming and finishing paint of 0.06 mm each. Attention shall be paid to the need to achieve adequate coverage at metal edges, where breakdown of the paint film often begins. The paint system and the colour of the final coat shall be dark grey colour.

Attention shall be paid to the need to achieve adequate coverage at metal edges, where breakdown of the paint film often begins.

The paint system and the color of the final coat shall be subject to the approval of the Purchaser and preferably be a dark grey color.

12. Rating Plate

A stainless steel rating plate, of at least 1 mm thickness, shall be fitted to each transformer and shall carry all the information as specified in the Standards. The rating plate shall be fitted below the LV terminals.

13. Terminal Markings

All transformers shall have the primary and secondary terminal markings plainly and indelibly marked on the transformer adjacent to the relevant terminal.

14. Tank Marking

Each transformer shall have the kVA rating stencilled on the outside of the tank. The numerals shall be black, 75mm high, and positioned centrally below the HV bushings so as to be readily visible from the ground.

15. Terminal Leads

Outgoing leads shall be brought out through bushings. The leads shall be such that the core and coils may be removed with the least possible interference with these leads, and they shall be specially supported inside the transformer, to withstand the effects of vibration and handling during transport, hand cartage and short circuits.

16. Bushings

All bushings shall be porcelain clad, and shall be sealed to prevent ingress of moisture and to facilitate removal. The neutral bushings and stems shall be identical to those provided for phase terminations. Bushing palms shall be made of brass and have one 14 mm dia. hole.

In case of outdoor bushings, the HV terminals shall be fitted with moulded heat shrinkable insulating covers suitable for 50 mm ACSR 'Rabbit' conductor to provide protection of the bushing palm. The LV bushings shall be in a cable box with suitable glands for cable sizes from 16-150 mm2.

17. Arching horns

All the transformers shall be equipped with arching horns on HT outdoor bushings.

18. Earthing Connections

Two earthing connections shall be provided with connection facilities for $25 \ge 6$ mm GI strip. The bolts shall be located on the lower side of the transformer and be of M12 size. Each connection shall be indicated clearly with an engraved 'earth' symbol.

19. Gaskets

Gaskets provided with the transformers shall be suitable for making oil tight joints, and there shall be no deleterious effects on either gaskets or oil when the gaskets are continuously in contact with hot oil. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight/UV. The material for gaskets shall be cork, neoprene or equivalent.

20. Drying Out, Filling, Transformer Oil

All transformers shall be thoroughly dried out at the manufacturer's works. Oil immersed type transformers shall be delivered filled with oil to normal level, ready for service, except that conservators may be removed for transport.

All transformers shall be filled to the required level with new, unused, clean, standard mineral oil in compliance with BS148/IEC-60296 and shall be free from all traces of polychlorinated biphenyl (PCB) compounds.

21. Fittings

The following standard fittings shall be provided:

- Rating and terminal marking plates non-detachable of aluminium material
- Earthing terminals with lugs 2 Nos.
- Lifting lugs for main tank & top cover
- Pulling lugs 4 Nos
- HV bushings with arching horns
- LV bushings inside the cable box as per site requirement and neutral bushings (for high rating transformers).
- Metallic conservator tank (mandatory for 50 kVA and above for rated voltage 11 kV and below, and all ratings above 11 kV) with oil gauge
- Terminal connectors on the HV/LV bushings
- Thermometer pocket with cap.
- Air release device (bolted type) for all transformers fitted with conservator tank
- Radiators
- Prismatic oil level gauge
- Drain cum sampling valve
- Oil filling hole having M30 thread with plug and drain valve on the conservator
- Silica gel breather (25 kVA and above for rated voltage 11 kV and below and all ratings above 11 kV). Type of breather (Bolted type is preferred).
- Pressure relief device or explosion vent.
- Metallic off-load tap changer
- Base channel ISMC 75 x 40 mm with M16 bolts and nuts to fix on mounting platform (for pole mounted stations, spacing of the holes to be decided base on pole type (steel tubular / telescopic pole).
- MCCB at LT side inside a cable box for transformers rated 250 kVA and below.

• ACB at LT side inside a cable box for Transformer rated 500kVA.

Transformers 125 kVA and below will be mounted on pole platform structures with four 16 mm dia bolts. The bolts spacing shall be 400 mm centre-centre for transformers up to and including 25 kVA and 500 mm centre- centre for transformers above 25 kVA capacity. The transformer tank base shall be provided with two steel channels to allow bolting to pole platforms. The 2 holes on the same channel should be spaced 227 mm centre-centre for transformers up to and including 25 kVA and spaced 242 mm centre- centre for transformers above 25 kVA capacity.

Pad mounted transformers below 500 kVA shall have skid type under base channels having towing holes for pulling & mounting holes for foundation of transformer. For heavy transformers of 500kVA and above, the under base shall be equipped with rollers allowing the unit to be manoeuvred into final position and then anchored.

22. Radio Interference

When operated at voltages up to 10% in excess of the normal system rating, transformers shall be substantially free from partial discharges; i.e., corona discharges in either internal or external insulation, which are likely to cause interference with radio or telephone communications.

23. Packing

Wooden pallets shall be provided for each transformers suitable for international transport and delivery to the Purchaser's warehouse. Bushings and other parts liable to damage shall be additionally protected. The transformers shall be securely bolted to pallets suitable for handling by forklift. In addition, the normal lifting eyes shall be accessible with handling by slings from a crane.

Providing of crate shall be at the discretion of the supplier. In case, if the crate is provided for protection, then each crate shall be clearly marked with the rating and voltage of the transformer, and the total transport weight.

24. TEST STANDARDS

24.1 Inspection and Testing

The supplier shall carry out a comprehensive inspection and testing program during manufacture of the equipment. An indication of inspection envisaged by the purchaser is given under Clause 3.1.1. This is however not intended to form a comprehensive program as it is supplier's responsibility to draw up and carry out such a program in the form of detailed quality plan duly approved by purchaser for necessary implementation.

24.2 Inspection

Tank and Conservator

- a) Certification of chemical analysis and material tests of plates.
- b) Check for flatness.

- c) Electrical interconnection of top and bottom by braided tinned copper flexible.
- d) Welder's qualification and weld procedure.
- e) Testing of electrodes for quality of base materials and coatings.
- f) Inspection of major weld preparation.
- g) Crack detection of major strength weld seams by dye penetration test.
- h) Measurement of film thickness of:
 - Oil insoluble varnish.
 - Zinc chromate paint.
 - Finished coat.
- i) Check correct dimensions between wheels, demonstrate turning of wheels through $90^{\circ}C$ and further dimensional check.
- j) Check for physical properties of materials for lifting lugs, jacking pads, etc. All load bearing welds including lifting lug welds shall be subjected to NDT.
- k) Leakage test of the conservator.
- l) Certification of all test results.

24.3 Core

- a) Sample testing of core materials for checking specific loss, bend properties, magnetisation characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings :
 - Measurement of thickness and hardness of varnish on stampings.
 - Solvent resistance test to check that varnish does not react in hot oil.
 - Check overall quality of varnish by sampling to ensure uniform shining colour, no bare spots, no over burnt varnish layer and no bubbles on varnished surface.
- c) Check on the amount of burrs.
- d) Bow check on stampings.
- e) Check for the overlapping of stampings. Corners of the sheet are to be part.

- f) Visual and dimensional check during assembly stage.
- g) Check for interlaminar insulation between core sectors before and after pressing.
- h) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.
- i) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- j) High voltage test (2 kV for one minute) between core and clamps.
- k) Certification of all test results.

24.4 Insulation Material

- a) Sample check for physical properties of materials.
- b) Check for dielectric strength.
- c) Visual and dimensional checks.
- d) Check for the reaction of hot oil on insulating materials.
- e) Dimension stability test at high temperature for insulating material.
- f) Tracking resistance test on insulating material.
- g) Certification of all test results.

24.5 Winding

- a) Sample check on winding conductor for mechanical properties and electrical conductivity.
- b) Visual and dimensional checks on conductor for scratches, dent marks etc.
- c) Sample check on insulating paper for pH value, bursting strength and electric strength.
- d) Check for the reaction of hot oil on insulating paper.
- e) Check for the bonding of the insulating paper with conductor.
- f) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- g) Check for absence of short circuit between parallel strands.

- h) Check for brazed joints wherever applicable.
- i) Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.
- j) Conductor enamel test for checking of cracks, leakage and pin holes.
- k) Conductor flexibility test.
- 1) Heat shrink test for enamelled wire.
- m) Certification of all test results.

24.6 Checks before Drying Process

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulation of core shall be tested at 2 kV/minute between core to bolts and core to clamp plates.
- e) Check for proper cleanliness and absence of dust etc.
- f) Certification of all test results.

24.7 Checks during Drying Process

- a) Measurement and recording of temperature, vacuum and drying time during vacuum treatment.
- b) Check for completeness of drying by periodic monitoring of IR and Tan delta.
- c) Certification of all test results.

24.8 Assembled Transformer

- a) Check completed transformer against approved outline drawings, provision for all fittings, finish level etc.
- b) Test to check effective shielding of the tank.
- c) Jacking test with oil on all the assembled transformers.
- d) Dye penetration test shall be carried out after the jacking test.

24.9 Bought Out Items

- a) The makes of all major bought out items shall be subject to Purchaser's approval.
- b) The Contractor shall also prepare a comprehensive inspection and testing programme for all bought out/sub-contracted items and shall submit the same to the Employer for approval. Such programme shall include the following components:
 - Buchholz Relay.
 - Axles and wheels.
 - Winding temperature indicators for local and remote mounting.
 - Oil temperature indicators.
 - Bushings.
 - Bushing current transformers.
 - Cooler control cabinet.
 - Cooling equipment.
 - Oil pumps.
 - Fans/Air Blowers
 - Tap change gear.
 - Terminal connectors.

The above list is not exhaustive and the supplier shall also include other bought out items in his programme.

24.10 Factory Tests

Routine Tests

All standard routine tests in accordance with IS: 2026 with dielectric tests corresponding to Method 2 shall be carried out on each transformer. Operation and dielectric testing of OLTC shall all be carried out as per IS: 2026.

Following additional routine tests shall also be carried out on each transformer:

a) Magnetic Circuit Test

After assembly each core shall be tested for 1 minute at 2000 Volts between all bolts, side plates and structural steel work.

- b) Oil leakage test on transformer tank
- c) Magnetic balance test
- d) Measurement of no-load current with 415V, 50 Hz AC supply on LV side.
- e) Frequency response analysis (FRA)
- f) Noise level test
- g) Heat run test
- g) Pressure test

Type Tests

Following type tests shall be conducted on one Transformer of each rating:

a) Temp. Rise Test as per IS: 2026 (Part-II)

Gas chromatographic analysis on oil shall also be conducted before and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 567. For the evaluation of the gas analysis in temperature rise test the procedure shall be as per IS: 9434 (based on IEC: 567) and results will be interpreted as per IS: 10593 (based on IEC -599).

The temperature rise test shall be conducted at a tap for the worst combination of loading on the three windings of the transformer. The supplier before carrying out such test shall submit detailed calculations showing alternatives possible, on various taps and for the three types of ratings of the transformer and shall recommend the combination that results in highest temperature rise for the test.

- b) Tank vacuum Test
- c) Tank pressure Test
- d) Pressure Relief Device Test.

The pressure relief device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released.

e) Measurement of capacitance and tan delta to determine capacitance between winding and earth.

f) Lightning Impulse withstand test in all phases as per IS: 2026 (As type test, only for 220 kV class & below)

Additional type tests

Following additional type tests other than type and routine tests shall also be carried out on one unit of each type:

- a) Measurement of zero Seq. reactance (As per IS: 2026, for 3-phase transformer only.)
- b) Measurement of acoustic noise level.
- c) Measurement of power taken by fans and oil pumps.
- d) Measurement of harmonic level in no load current.
- e) One cooler control cabinet of each type shall be tested for IP: 55 protection in accordance with IS: 13947.
- f) Measurement of transferred surge on LV (tertiary) winding due to HV lightning impulse and IV lightning impulse.
- g) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

Routine tests on bushings

The following tests shall be conducted on bushings

- a) Test for leakage on internal fillings.
- b) Measurement of creepage distance, dielectric dissipation factor and capacitance.
- c) Dry power frequency test on terminal and tapping.
- d) Partial discharge test followed by dielectric dissipation factor and capacitance measurement.

Tank Tests

a) Routine Tests

Oil Leakage Test

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35

KN/Sq.m (5 psi) measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air during which time no leak shall occur.

b) Type Tests

i. Vacuum Test

Where required by the purchaser one transformer tank of each size shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

 Horizontal Length	Permanent deflection
of flat plate (in mm)	(in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

- -----
- ii. Pressure Test

One transformer tank of each size, its radiator, conservator vessel and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m2 whichever is lower measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

24.11 Pre-Shipment Checks at Manufacturer's Works

a) Check for interchangeability of components of similar transformers for mounting dimensions.

- b) Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
- e) Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.
- f) Gas tightness test to confirm tightness.
- e) Derivation of leakage rate and ensure the adequate reserve gas capacity.

i. Note

- a) Accuracy class PS as per IS:20705
- b) Class (for the relevant protection and duties) as per IEC 185.

Lot 5: Lubricants

The insulating oil shall conform to all parameters either as per IEC-60296 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#	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 29.5 ^ø C (max.)	0.89 gm/cm3	IS: 1448
3	Kinematic Viscocity at27 [¢] C (Max.)	27 cSt	IS: 1448
4	Interfacial Tension at27 ^ø C (Min.)	0.04 N/m	IS: 6104
5	FlashpointPenskey-Marten(closed) (Min.)	140°C	IS: 1448
6	Pour point (Max.)	-30 ^ø C	IS: 1448
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	IS: 335 Appendix-1
9	Electric strength (Breakdow	n voltage) (Min.)	<u> </u>
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 ^ø C	1500x10 ¹²	
11	Oxidation stability		
a)	Neutralization value after oxidation (Max.)	0.40 mg KOH/gm	
b)	Total sludge after oxidation (Max)	0.10 percent by weight	
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 9	96hrs as per ASTM-D1934/IS: 121	77 with catalyst (Copper)
a)	Resistivity(Min) (ohm cm) at 27 ^ø C at 90 ^ø C	2.5×10^{12}	
		0.2×10^{12}	
b)	Tan delta at 90 ^o C (Max.)	0.2	
c)	Total acidity (Max.)	0.05 mg KOH/gm	
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.)	
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- (2) Moisture content 15 ppm (max.)
- (3) Tan-delta at 90° C
- (4) Resistivity at 90° C
- (5) Interfacial Tension
- 0.05 (max.) 1 x 10¹² ohm-cm (min.)
- 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.)
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(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).

Lot 6: Earthing Equipment

Spike Earthing

Spike earthing is used for 11 kV & 33 kV pole earthing. Spike Earthing consist of 25x6 mm, 1.5 meter long GI flat, 2.5 meter long spike earthing electrode with necessary holes as indicated on the drawing.

GI Strip

GI strip/earth conductor of 25 x 6 mm shall be supplied for connection from LV neutral, transformer earth and lightning arrestor to the earthing electrode.

GI Wire

Earthing connection of 8 SWG GI wires shall be supplied, for connection from the pole to the spike earthing electrode

Stay Wire

Utilities grade galvanised steel strand shall be used for guy wire as shown in the table: Galvanised Steel Stay Wires

Designation	No	Strand	Strand	Overall	Appro. Wt.	Minimum
	Strands	SWG^1	Diameter	dia	Per meter	breaking load
			(mm)		(kg)	(kN)
7/8	7	8	4.04	12	0.72	90

Care must be taken in procuring guy wire to ensure that the wire has the minimum breaking load specified in the table. Galvanised steel wire is available is a range of steel grades and only utilities grade wire, manufactured using a high tensile steel, should be used.

Lot 7: Galvanized Steel Tubular Poles

Scope

This specification covers the design, manufacture, testing, supply, delivery and performance requirements of Galvanized Steel Tubular Poles.

Standards

The equipment shall comply with the latest editions of and amendments to Indian standards listed below. Where any provision of this specification differs from those of the standards listed hereafter, the provision of this specification shall govern.

IS - Indian Standards

- IS 2713: Specification for steel poles for overhead power lines
- IS 2062: Steel for general structural purposes

Note:

In case of conflict, the order of precedence shall be:

- This Specification
- IS Standards
- Other Standards

Alternative Standards may be approved, provided the Supplier demonstrates that they give a degree of quality and performance equivalent to that of the referenced Standards. Acceptability of any alternative Standard is at the discretion of the Purchaser.

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.

Pole Lengths

Pole Length	Pole Strength / Working Load	Equivalent to Indian Standard Specification reference	Equivalent to IS Pole Designation	Weight per pole
7.5M	410Mpa	IS 2713	410-SP-9	110 kg.
10M	410Mpa	IS 2713	410-SP-45	178 kg.
12M	410Mpa	IS 2713	410-SP-62	259 kg.

Poles are required in two sections. Refer table below and drawings enclosed. The poles shall be of steel swaged type, conforming to the appropriate Standard. Refer Drawing enclosed.

Construction of Poles

Material

The poles shall be made from longitudinally welded tube sections of hot rolled structural carbon steel having the mechanical strength properties as follows:

- (a) Tensile strength: 410 MPa
- (b) Yield strength: 240 MPa

Or from steels having similar mechanical properties, manufactured under Standards, approved by the Purchaser.

Galvanising

Galvanising of the steel poles shall be in accordance with ISO 1459 and ISO 1461. The zinc coating shall not be less than 600 g/m^2 of steel surface area.

The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the smelter bath, which could have a deleterious effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding must be completed and all grease, paint, varnish, oil and welding slag completely removed. All protuberances, which would affect the life of galvanising, should also be removed.

To avoid the danger of white rust, galvanised material shall be stacked during transport and stored in such a manner as to permit adequate ventilation.

Galvanised steel items shall be thoroughly checked for damage before transport to the work site.

Any material found to be damaged shall be returned to its source. Cracked, flaked or scratched surfaces shall not be acceptable.

Galvanised steel shall be handled carefully during loading, transporting and unloading, and shall not be dropped on the ground, or dragged or scraped along the ground or any surface.

Shape, Assembly of Poles

Poles are to be manufactured in swaged form.

Swaged poles shall be manufactured from tubes worked while hot. Swaged poles shall consist of two tube sections with tapering diameters, the bottom section having the largest diameter. The length of the overlap shall be at least three times the diameter of the smaller tube, in each case. The Supplier shall state the length of overlap. The upper edge of the tube at each joint shall be chamfered at an angle of 45° .

The poles shall be supplied in two sections for assembly at site by bolting. Galvanised bolts of adequate strength, required for joining the poles at site, shall also be supplied, with manufacturer's instructions for the pole assembly.

Transportation of full-length poles is avoided in Bhutan, due to hand cartage in the mountainous terrain.

Cost of bolts, nuts and washers for joining pole sections shall be deemed included in the schedule rates for pole supply.

Bolts, Nuts and Washers

All bolts, nuts and washers, supplied under this Specification shall comply with the following:

The bolts and nuts shall comply with ISO 4016. Mechanical properties shall be in accordance with ISO 898.

The dimensions and characteristics in this Specification are intended to describe typical ISO metric bolts, nuts, and washers, such as are commonly used in the construction of electrical distribution lines, plant and equipment.

The safe working shear stress of bolts is taken as 120 MPa, with the area of the bolt measured at the root of the thread. The table below shows the ultimate tensile strength, the tensile stress areas, the safe working tensile loads and the safe working shear loads for the bolts covered by this Specification. The ultimate shear strength has been assumed to be 75% of the ultimate tensile load and a factor of safety of 2.5 has been applied:

Bolt Size	Ultimate Tensile Stress (N/mm ²)	Tensile Stress Area (mm²)	Ultimate Tensile Strength (kN)	Working Tensile Load (kN)	Safe Working Shear Load (kN)
M16	400	157.0	62	25	18
M18	400	204.0	81	32	24
M20	400	245.0	98	39	29

Screw threads shall be parallel throughout their length. They shall be so formed that, after galvanising, the nut can be easily screwed by hand over the whole length of thread, without excessive play. Before despatch from the works, one washer shall be fitted to each bolt and a nut shall be screwed on the whole threaded length and left in that position. Washers shall be round, flat, of mild steel, unless where otherwise specified.

Identification Marks

The following identification marks shall be legibly engraved/ punched/ embossed on each pole at a height of 3m from bottom end of the pole, before painting:

- (a) Manufacturer's name/Trade mark
- (b) Year of manufacture
- (c) Batch Number

The size of the letters shall be at least 5mm and the depth of engraving/height of embossing shall be such that the text remains legible after painting.

Quality Control

All poles shall be inspected by an inspector appointed by the Purchaser. The Supplier shall assist the work of the Purchaser's inspector by providing copies of all relevant Standards, and allowing the inspector full use of the necessary tapes, measures and laboratory equipment, together with ample space and assistance in the handling of poles for inspection. Any costs incurred by the Supplier in aiding the inspector shall be deemed to be included in the contract.

Poles as delivered to the designated stores shall be free of all damage to protective paint coating, and shall not be out of straight by more than one thousandth of the length of the pole.

The inspector shall examine the poles for, among other things, the following characteristics:

- General appearance;
- Finish;
- Dimensions; and
- Straightness.

At least the following dimensional checks shall be made by the inspector:

- Length;
- Butt diameter and circumference;
- Top diameter and circumference;
- Non-circularity;
- Accuracy of drillings;
- Suitability of pole sections to overlap and bolt together;
- Straightness, where appropriate;
- Internal dimensions.

The group of poles or fittings offered at any one time shall constitute a batch. Within a batch, poles and fittings presented for inspection shall be segregated on a size basis. If 5% of the inspected items show damage or serious deviations from the design criteria, the entire batch shall be unconditionally rejected without further sorting.

Dimensions, such as length and top diameter, shall be measured with a standard steel tape.

List of Tests

The following tests shall be carried out on samples drawn from each consignment of the poles:

- i) Deflection Test/Permanent Set Test
- ii) Drop Test.

Number of Samples to be Tested

The number of samples to be drawn from each consignment for testing shall be determined using the following formula:

$$S = 4 + \frac{1.5 N}{1000}$$
 where: $S =$ Number of samples
 $N =$ Quantity in consignment

The value of S obtained is subject to an absolute minimum of 4.

The test procedure for the above tests shall be mutually discussed and agreed between the Purchaser and the Supplier.

Rejection

All the samples subjected to above tests shall pass the tests. Should one or more number of poles fail in any of the test, a second set of samples, double in number shall be drawn and subjected to above tests. Should one or more number of poles from second set of poles fail in any of the tests, the entire consignment shall be rejected.

Tolerances

The poles shall meet the requirements of relevant standards IS 2713 in all respects. In case of weight of the pole, though the standard allows negative tolerance on the weight of the pole (for individual pole as well as for the LOT), while the acceptance of the poles will be based on their conformity to the standards (in case of weight within the specified tolerance limits), the payment will, however, be prorated for any reduction in weight from the standard weight based on to the actual weight of the LOT (within the specified limits) compared to the calculated weight for the LOT based on standard weight indicated in the standard.

For example,

IS 2713 allows 10% below the standard weight for individual poles, subject to 7.5% below the calculated standard weight for the LOT. If the pole and LOT weights are within the specified limits, the LOT will be considered as having met the requirement for acceptance, as far as weight is concerned, and will be accepted subject to its having met all other tests / requirements. However, the actual payment will be based on the following.

Payment as per contract rates = $R \times N$

Less reduction for lower weight = $R \times N \times \{(W_s-W_a)/W_s\}$

i.e Actual Eligible Payment = $R \times N \times (W_a / W_s)$

where,

R is the rate per pole in the contract N is the no. of poles in the LOT $W_s = N \times W$, where W is the standard weight per pole.

Lot 8: Pole Fittings

The Supplier shall provide the goods in complete form (which includes assembly at PSD's warehouse), which meets or exceeds these minimum requirements. The fittings need to be assembled at the factory and delivered. The bidders are advised to refer drawings for the details and sample shall be taken from PSD warehouse before mass fabrication. Stay Clamp

Galvanized Stay Set Assembly (88.9mm)

Sl. No	Parameters	UoM	Qty
1	Galvanized Stay Clamp (100x8)	No.	2
2	Galvanized Hexagonal Bolt M16X75	No.	2
3	Galvanized Hexagonal Nut M16	No.	2
4	Galvanized plain washer M16	No.	2

Galvanized Stay Set Assembly (114.3mm)

Sl. No	Parameters	UoM	Qty
1	Galvanized Stay Clamp (100x8)	No.	2
2	Galvanized Hexagonal Bolt M16X75	No.	2
3	Galvanized Hexagonal Nut M16	No.	2
4	Galvanized plain washer M16	No.	2

Galvanized Stay Set Assembly

Sl. No	Parameters	UoM	Qty
1	Galvanized Stay Plate (300x300x6) with 22 dia hole at its centre	No.	1
2	Stay Rod of 2.5m long with dia 20mm gi rod	Set	1
3	Turn Buckle (20mm dia GS Rod, CH 100X50X300 LG)	Set	1
4	Eye Bolt with Nuts, 16mm dia GI Rod , 460mm long	Set	1
5	Thimble 1.5mm thick gi sheet into a size of 75x22x40mm	No.	1
	shaper as per standard		

Galvanized Stay Rod

Sl. No	Parameters	UoM	Qty
1	Galvanized Stay Rod of 2.5m long with dia 20mm gi rod	Set	1

Galvanized Eye Bolt

Sl. No	Parameters	UoM	Qty
1	Eye Bolt with Nuts, 16mm dia GI Rod, 460mm long	Set	1

Galvanized Cross Arm Assembly for H-Frame

S1.#	Parameters	UoM	Qty
1	ISMC 100X50, 3150 mm length complete with necessary holes	Nos.	2
2	"M" Clamp	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 175 mm long, complete with	Set	4
	one Flat Washer and Spring Washer with Clamps		
4	MS Flat String Bracing, 50x6 mm, 227 mm length complete with	Nos.	6
	necessary holes for fixing insulators		
5	Sets of GI Nuts and Bolts, 16 mm dia, 150 mm long, complete with	Sets	6
	one Flat Washer and Spring Washer for Bolting MS Flat		

Galvanized Cross Bracing Assembly for H-Frame

S1.#	Parameters	UoM	Qty
1	MS Angle 50x50x6 mm, 2030 mm length complete with necessary holes	No.	1
2	MS Angle 50x50x6 mm, 2000 mm length complete with necessary holes	No.	1
3	MS Angle 50x50x6 mm, 2919 mm length complete with necessary holes	Nos.	2
4	Full Clamp (Pole dia 114.3 mm outer diameter)	Nos.	2
5	Full Clamp (Pole dia 165.1 mm outer diameter)	Nos.	2
6	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete with one	Sets	8
	Flat Washer and one Spring Washer		
7	Sets of GI Nuts and Bolts, 16 mm dia, 35 mm long, complete with one	sets	5
	Flat Washer and one Spring Washer		

Support for Lightning Arrestor

S1.#	Parameters	UoM	Qty
1	ISMC 75X40, 3150 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 139.7 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Set	4
	with one Flat Washer and one Spring Washer		

Galvanized support for ABS/LBS of steel tubular poles

S1. #	Parameters	UoM	Qty
1	ISMC 100X50, 3110 mm length complete with necessary holes	No.	2
2	Full Clamp (Pole dia 114.3 mm outer diameter)	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Handle support for ABS/LBS of Steel Tubular Poles

S1.#	Parameters	UoM	Qty
1	ISMC 70X40x6, 3110 mm length complete with necessary holes	Nos.	2
2	Full Clamp (Pole dia 165.1 mm outer diameter)	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Support for Drop Out Fuse of Steel Tubular Poles

S1.#	Parameters	UoM	Qty
1	ISMC 70X40, 3150 mm length complete with necessary holes	Nos.	2
2	Full Clamp (Pole dia 139.7 mm outer diameter)	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Support for Intermediate Channel of Steel Tubular Poles

S1.#	Parameters	UoM	Qty
1	ISMC 70X40, 3110 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 165.1 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	4
	with one Flat Washer and one Spring Washer		

Galvanized Support for Intermediate Jumper of Steel Tubular Poles

S1.#	Parameters	UoM	Qty
1	ISMC 100X50, 3110 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 139.7 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	4
	with one Flat Washer and one Spring Washer		

Galvanized Transformer Platform for Steel Tubular Poles

S1.#	Parameters	UoM	Qty
1	ISMC 100X50 (125x65), 3110 mm length complete with necessary	Nos.	2
	holes		
2	"M" Clamp	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 240 mm long, complete with	Sets	4
	one Flat Washer and one Spring Washer		
	Sets of MS Plate 310x5 mm, 2000 mm length complete with 8 Nos.	Set	1
	flat full threaded GI nuts and countersunk bolts, 12 mm dia, 25mm		
	length and trapezoid washer		

Transformer Belting for Steel Tubular Poles

Sl. #	Parameters	UoM	Qty
1	ISA 50x50x6 mm, 3165 mm length complete with necessary	Nos.	2
	holes		
2	ISMC 75x40x6 mm, 600 mm length complete with necessary	Nos.	2
	holes		
3	GI "L" hook suitable to hold the ISMC 75x40 mm and MS angle	Nos.	4
	together to suit the size of the transformer		
4	Full Clamp	Nos.	2
5	Sets of GI Nuts and Bolts, 16 mm dia, 50 mm long, complete with	Sets	4
	one Flat Washer and one Spring Washer		

Anti-climbing Device (Dia 139.7mm)

In order to prevent unauthorized person from climbing any of the supports of HT lines and substations, anti-climbing device are provided to each poles. Anti-climbing device shall be a clamp with protruding spikes installed at height of 3.5m -4m above the ground level for line and below 3m for substation.

Lot 9: Telescopic Pole Fittings

Galvanized Stay Clamp (Dia 163 mm) for Telescopic Pole

S1.#	Parameters	UoM	Qty
1	Galvanized Stay Clamp (100x16)	No.	2
2	Galvanized Hexagonal Bolt M16X150	No.	2
3	Galvanized Hexagonal Nut M16	No.	2
4	Galvanized plain washer M16	No.	2

Galvanized Support for ABS/LBS of Telescopic Poles

Sl. #	Parameters	UoM	Qty
1	ISMC 100X50, 3240 mm length complete with necessary holes	Nos.	2
2	Full Clamp (Pole dia 165 mm outer diameter)	Nos.	2
3	Full Clamp (Pole dia 218 mm outer diameter)	Nos.	2
4	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Handle Support for ABS/LBS of Telescopic Poles

S1. #	Parameters	UoM	Qty
1	ISMC 70X40x6, 3320 mm length complete with necessary holes	Nos.	2
2	Full Clamp (Pole dia 345 mm outer diameter)	Nos.	2
3	Full Clamp (Pole dia 351 mm outer diameter)	Nos.	2
4	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Support for Drop out Fuse of Telescopic Poles

Sl. #	Parameters	UoM	Qty
1	ISMC 70X40, 3149 mm length complete with necessary holes	Nos.	2
2	Full Clamp (Pole dia 190 mm outer diameter)	Nos.	2
3	Full Clamp (Pole dia 195 mm outer diameter)	Nos.	2
4	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	8
	with one Flat Washer and one Spring Washer		

Galvanized Support for Intermediate Channel of Telescopic Poles

S1. #	Parameters	UoM	Qty
1	ISMC 70X40, 3320 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 264 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	4
	with one Flat Washer and one Spring Washer		

Galvanized Support for Jumper of Telescopic Poles

Sl. #	Parameters	UoM	Qty
1	ISMC 100X50, 3240 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 133 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Sets	4
	with one Flat Washer and one Spring Washer		

Support for Lightning Arrestor of Telescopic Poles

Sl. #	Parameters	UoM	Qty
1	ISMC 75X40, 3198 mm length complete with necessary holes	No.	1
2	Full Clamp (Pole dia 240 mm outer diameter)	Nos.	2
3	Sets of GI Nuts and Bolts, 16 mm dia, 100 mm long, complete	Set	4
	with one Flat Washer and one Spring Washer		

Substation Cross Arm Assembly of Telescopic Poles

S1. #	Parameters	UoM	Qty
1	ISMC 100X50, 3240 mm length complete with necessary holes	Nos.	2
2	"M" Clamp	Nos.	4
3	Sets of GI Nuts and Bolts, 16 mm dia, 175 mm long, complete	Sets	4
	with one Flat Washer and one Spring Washer		
4	Sets of MS flat string bracing, 50x6 mm, 227mm length complete	Sets	6
	with necessary holes		
5	Sets of GI Nuts and Bolts, 16 mm dia, 150 mm long, complete	Sets	6
	with one Flat Washer and one Spring Washer		

Transformer Belting for Telescopic Poles

Sl. #	Parameters	UoM	Qty
1	ISA 50x50x6 mm, 3300 mm length complete with necessary holes	Nos.	2
2	ISMC 75x40x6 mm, 800 mm length complete with necessary holes	Nos.	2
3	GI "L" hook suitable to hold the ISMC 75x75 mm and MS angle	Nos.	4
	together to suit the size of the transformer		
4	Full Clamp	Nos.	2
5	Sets of GI Nuts and Bolts, 16 mm dia, 50 mm long, complete with	Sets	4
	one Flat Washer and one Spring Washer		

Bolts, Nuts and Washers

All bolts, nuts and washers, supplied under this Specification shall comply with the following:

The bolts and nuts shall comply with ISO 4016. Mechanical properties shall be in accordance with ISO 898. The dimensions and characteristics in this Specification are intended to describe typical ISO metric bolts, nuts, and washers, such as are commonly used in the construction of electrical

distribution lines, plant and equipment. The safe working shear stress of bolts is taken as 120 MPa, with the area of the bolt measured at the root of the thread. The table below shows the ultimate tensile strength, the tensile stress areas, the safe working tensile loads and the safe working shear loads for the bolts covered by this Specification. The ultimate shear strength has been assumed to be 75% of the ultimate tensile load and a factor of safety of 2.5 has been applied:

Bolt Size	Ultimate Tensile Stress (N/mm ²)	Tensile Stress Area (mm ²)	Ultimate Tensile Strength (kN)	Working Tensile Load (kN)	Safe Working Shear Load (kN)
M16	400	157.0	62	25	18
M18	400	204.0	81	32	24
M20	400	245.0	98	39	29

Screw threads shall be parallel throughout their length. They shall be so formed that, after galvanising, the nut can be easily screwed by hand over the whole length of thread, without excessive play. Before despatch from the works, one washer shall be fitted to each bolt and a nut shall be screwed on the whole threaded length and left in that position. Washers shall be round, flat, of mild steel, unless where otherwise specified.

Galvanising

Galvanising shall be in accordance with ISO 1459 and ISO 1461. The zinc coating shall not be less than 600 g/m^2 of steel surface area.

The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the smelter bath, which could have a deleterious effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding must be completed and all grease, paint, varnish, oil and welding slag completely removed. All protuberances, which would affect the life of galvanising, should also be removed.

To avoid the danger of white rust, galvanised material shall be stacked during transport and stored in such a manner as to permit adequate ventilation.

Galvanised steel items shall be thoroughly checked for damage before transport to the work site.

Any material found to be damaged shall be returned to its source. Cracked, flaked or scratched surfaces shall not be acceptable.

Galvanised steel shall be handled carefully during loading, transporting and unloading, and shall not be dropped on the ground, or dragged or scraped along the ground or any surface.

Painting

After manufacture, all items shall be painted for protection against corrosion.

The fittings shall be thoroughly cleaned by wire brush and the weld flux, if any, shall be removed. Phosphate treatment shall then be given, followed by light wiping by wet cloth. In accordance to the preparation of steel substrates before application of paints and related products ISO8502-4:1999 After drying, fittings shall be coated with bituminous preservative paint on the inside as well as on the outside surface over the length of pole, which is buried in the pole foundation; i.e. below ground. The ground line position shall be at approximately 1/6 of the total pole length.

The remaining exposed outside surface shall be painted with one coat of red oxide anti-rust primer with a dry film thickness of 40 Micrometres, prior to delivery, in accordance with ISO 12944-7 Paints and Varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work - ISO 12944-7:1998.

Identification Marks

The following identification marks shall be legibly engraved/ punched/ embossed on each pole at a height of 3m from bottom end of the pole, before painting:

- 1. Manufacturer's name/Trade mark
- 2. Year of manufacture
- 3. Batch Number

The size of the letters shall be at least 5mm and the depth of engraving/height of embossing shall be such that the text remains legible after painting.

Quality Control

All fittings shall be inspected by an inspector appointed by the Purchaser. The Supplier shall assist the work of the Purchaser's inspector by providing copies of all relevant Standards, and allowing the inspector full use of the necessary tapes, measures and laboratory equipment, together with ample space and assistance in the handling of poles for inspection. Any costs incurred by the Supplier in aiding the inspector shall be deemed to be included in the individual pole price.

Fittings as delivered to the designated stores shall be free of all damage to protective paint coating, and shall not be out of straight by more than one thousandth of the length of the pole.

Annexure-II

Lot 2: Switching Equipment

Item No. 3&4 (Drop Out Fuse three phase)							
<i></i>			Bidders	Bidders to fill up			
SI. #	Parameters	Units	11kV	33kV			
1	Manufacturer						
2	Manufacturer's Type Designation						
3	Applicable Standards			•			
4	Туре						
5	Rated Voltage	kV					
6	Rated normal current (rms)	А					
7	Rated current of the fuse base	А					
8	Rated load current breaking capacity	А					
9	Insulation level:						
	Dry Impulse withstand (1.2kV/50µs) (positive & negative polarity) (peak)) voltage)					
a	Across the isolating distance of the fuse base	kV					
b	To earth and between poles kV	kV					
10	Wet 1 min. Power frequency withsta voltage (rms)	and					
a	Across the isolating distance of the fuse base	kV					
b	To earth and between poles	kV					
11	Rated short time breaking capacity	kA					
12	Minimum creepage distance	mm					
13	Mounting Arrangement						
17	Weight	kg					

Item No. 5&6 (LBS)							
SL#	Parameters	Unit	Bidders to fill up				
			11 kV	33 kV			
1	Applicable Standard						
2	Rated normal current						
3	Rated 1 sec. withstand current	kA					
4	Rated peak withstand current						
5	Rated Power frequency withstand voltage						
а	Across open contacts	kV					
b	To Earth and Between poles						
6	Rated impulse withstand voltage						
a	1. Across open contacts	kV					
b	2. To Earth and Between poles	kV					

Annexure III

Lot 2: Switching Equipment





Lot 3: Lightning Arrestor





- 1. Dimensions as shown are in mm
- 2. Drawing not to Scale
- 3. Applicable Standard IS: 3070, IEC 60099-4
- 4. Dimension of Lightning Arrester shall be as per manufacturer standard



BHUTAN POWER CORPORATION LIMITED (BPC)

PROCUREMENT SERVICES DEPARTMENT

Particular

30

10

24.4

85

71.8

60

50

LIGHTNING ARRESTER 30kV, 10kA

Lot 6: Earthing Equipment









Description	Quantity	Materials	Size
Earthing Rod	1	HDG Steel	M20 x 2500
Bolt Hex.	4	HDG Steel	M6 x 25 x FT
Earthing Flat 25x6 mm	1	HDG Steel	1.5 Meter
Nut Hex.	4	HDG Steel	M6
Spring Washer	4	HDG Steel	M6

Grade of Steel: BS 4360 Grade 43A or Equivalent Galvanized: BS 729 or Equivalent

BHUTAN POWER CORPORATION			PROCUREMENT SERVICES DEPARTMENT	
BPC	IMITED		SPIKE EARTHING SET	
	NAME	DATE		
REPARED BY	PSD			

	sformers	Offered Brand and Unit Price DDP Total Price DI Origin of Country (Nu.) (Nu.)						ndia.		
Annexure-IV	for Lot 4: Distribution Tran	Restricted Brands	• K anohar Flectrical I td - India	Nucon Switchgear (P) Ltd., India Kotsons Pvt. Ltd., India	NEEK, Nepal Uttam Bharat, India	Universal Power Transformers, India Kirloskar Electric company, India	 PT Trafindo, Indonesia Truvolt Engineering, India 	 Technical Associate Ltd., India Trafo Power and Electrical Pvt. Ltd. In 		(
	Schedu	Qty	8.00	2.00	5.00	5.00	3.00	1.00	3.00	nt (Nu.
	Price (UoM	SET	SET	SET	SET	SET	SET	SET	Amou
		Description	Dist. Transformer 500 kVA, 11/0.415 kV	Dist. Transformer 500 kVA, 11/0.415kV-(Indoo	Dist. Transformer 250 kVA, 33/0.415 kV	Dist. Transformer 500 kVA, 33/0.415 kV	1 phase Transformer 16 KVA 11/.240 kV	1 Phase Transformer 25 kVA, 11/0.240 kV	1 Phase Transformer 25 kVA, 33/0.240 kV	Total

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