

CHAPTER - E5- 1

TECHINICAL SPECIFICATIONS FOR 3.15 / 5.00 / 8.00 MVA, 33/11KV ONAN POWER TRANSFORMERS

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OF
POWER TRANSFORMERS

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TECHINICAL SPECIFICATION FOR 33/11KV ONAN POWER

TRANSFORMERS

1. SCOPE

- 1.1 This Specification provides for design, manufacture, assembly, stage inspection, final inspection and testing before despatch, packing and delivery at destination Sub-station by road transport, transit insurance, unloading at site of **3.15 / 5.00 / 8.00 MVA, 33/11kV Power Transformers**, complete with all fittings, accessories, associated equipment, Spares, 10% extra Transformer Oil, required for its satisfactory operation.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

The Transformer shall be of outdoor type with tap changers as detailed below.

3.15 MVA -	OFF Load Tap Changer
5.00 MVA -	OFF Load Tap Changer
8.00 MVA -	ON Load In Tank/Flange Mounted type Tap Changer (with RTCC Panel)

- 1.2 **The core shall be constructed from high grade, non-aging Cold Rolled Grain Oriented (CRGO) Silicon Steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better quoted grade Core. The maximum flux density in any part of the core and yoke at normal voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.**

- 1.3 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship based on this specification and the latest revisions of relevant standards at the time of offer. OPTCL shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or in the commercial order or not.

OPTCL reserves the right to reject the transformer(s)-

- i) if on testing the No-load and load- losses exceed the stipulated values as per this Technical Specification
- ii) if the temperature rise in oil and / or winding exceeds the value as per this Technical Specification
- iii) if impedance value differs from the guaranteed value including tolerance as per this specification
- iv) On Inspection and testing, if any of the technical data does not comply to this specification, bid offer and approved drawings etc.

1.4 The offered rating transformer should have been tested for 'Short Circuit withstand capability test' and 'Impulse test' in an NABL accredited Government Laboratory as per relevant IS/IEC and the Type Test certificates in complete shape shall be accompanied with the bid offer.

2. TECHNICAL REQUIREMENTS OF POWER TRANSFORMER

1	Rated MVA of Transformer (ONAN rating)	3.15MVA 5.00MVA 8.00MVA
2	No. of Phases	3
3	Type of Installation	Outdoor
4	Frequency	50 Hz (- 5% to +3%)
5	Cooling medium	Insulating Oil (ONAN)
6	Type of mounting	On Wheels, Mounted on rails.
7	Rated voltage	
	a) High Voltage Winding	33 kV
	b) Low Voltage Winding	11 kV
8	Highest continuous system Voltage	
	a) Maximum system Voltage ratio (HV / LV)	36 kV/ 12 kV
	b) Rated Voltage ratio (HV / LV)	33 kV/ 11 kV
9	No. of windings	Two winding Transformers
10	Type of cooling	ONAN (Oil natural & Air natural)
11	MVA Rating corresponding to ONAN cooling system	100%
12	Method of connection:	
	HV:	Delta
	LV:	Star
13	Connection symbol	Dyn 11
14	System earthing	Neutral of LV side to be solidly earthed.
15	Percentage impedance voltage on Normal tap and MVA base at 75°C corresponding to HV/ LV rating and applicable tolerances :	% Impedance for 3.15 MVA - 6.25%, 5 MVA - 7.15% 8 MVA - 8.35% (Tolerance +10%) (No negative tolerance will be allowed)
16	Intended regular cyclic overloading of windings	As per IEC –76-1, Clause 4.2
17	a) Anticipated unbalanced loading	Around 10%
	b) Anticipated continuous loading of windings (HV / LV)	110 % of rated current
18	Type of tap changer	On-Load In-tank or flange mounted Type tap changer for 8 MVA and OFF load in 3.15 and 5 MVA transformer
	Range of taping	+ 5% to – 15% in 8 equal steps of 2.5% each on HV winding, 9 tap positions. Tap No 3 will be the Principal tap position.
19	Neutral terminal to be brought out	On LV side only
20	Over Voltage operating capability and duration	112.5 % of rated voltage (continuous)
21	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage	1.5 Tesla

	i.e 33kV / 11kV and system frequency of 50 Hz	
22	Insulation levels for windings :-	33 kV 11 kV
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	170 95
	b) Power frequency voltage withstand (KVrms)	70 28
23	Type of winding insulation	
	a) HV winding	Uniform
	b) LV winding	Uniform
24	Withstand time for three phase short circuit	As per IS
25	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.
26	Permissible Maximum Temperature Rise over ambient temperature of 50° C	
	a) Of top oil measured by thermometer.	35° C
	b) Of winding measured by resistance.	40° C
	c) Hot Spot Temperature rise	54° C
27	Minimum clearances in air (mm) :-	Phase to Phase Phase to ground
	a) HV	400 320
	b) LV	280 140
28	Terminals :-	
	a) HV winding line end	36kV oil filled communicating type porcelain bushings (Antifog type)
	b) LV winding	12kV porcelain type of bushings (Antifog type)
29	Insulation level of Bushing :-	HV LV
	a) Lightning Impulse withstand (KVP)	170 95
	b) 1 Minute Power Frequency withstand voltage (KV-rms)	70 28
	c) Creepage distance (mm) (minimum)	900 300
30	Material of HV & LV Conductor	Electrolytic Copper
31	Maximum current density for HV and LV winding for rated current at normal tap	2.4 A/ mm ²
32	Polarisation Index i.e ratio of Megger values at 600 sec. to 60 sec for HV to earth, L.V to earth and HV to LV	Shall be greater than or equal to 1.5, but less than or equal to '5'.
33	Core Assembly	Boltless type
34	Temperature Indicator	
	a) Oil	One number
	b) Winding	One number
35	Maximum permissible no load loss at rated voltage and rated frequency.	3.15MVA-3.0 KW (Maximum) 5.0MVA- 3.6. KW (Maximum) 8.0MVA- 4.5KW (Maximum)
36	Maximum permissible load loss at rated current, at normal tap and at 75° C	3.15MVA-17.0 KW (Maximum) 5.0MVA- 21.0. KW (Maximum) 8.0MVA- 38.0KW (Maximum)
37	Paper Covering thickness of HV Winding Conductor	0.6 mm(minimum)
38	Paper Covering thickness of LV Winding	0.5 mm(minimum)

	Conductor	
39	Clearances:-	
	a) Gap between HV Coil to the inside of the tank on the longer side	65 mm(minimum)
	b) Gap between HV Coil to the inside of the tank on the width side (LV Side)	65 mm(minimum)
	c) Gap between HV Coil to the inside of the tank on the width side (HV Side to accommodate delta and tapping leads)	115 mm(minimum)
	d) Gap between Core yoke to tank bottom	55 mm(minimum)
	e) Yoke insulation at top and bottom	130 mm(minimum)
	f) Phase to Phase clearance between HV Limbs	20 mm(minimum)
	g) Radial Clearance between LV and HV Coil	20 mm(minimum)
	h) Radial Clearance between Core to LV Coil	12.5 mm(minimum)
40	The difference of Ampere Turns at each location shall not be more than 5 % at all percentages of tappings	
41	Winding to winding clearance should have minimum 20% of sum of pressboard Cylinder/Barrier.	
42	Tap changing gear:-	
(i)	Type-	In Tank,High Speed Resistor Type
(ii)	Provided on	HV Side
(iii)	Tap range	-15% to +5%
(iv)	Tap Step	2.5% of 33kV (8 equal steps)
(v)	Minimum Rated current	For 3.15 MVA-100A,5 MVA-150A & 8 MVA-200A
(vi)	Minimum Rated short circuit current	3KA
(vii)	Automatic control required	YES
(viii)	Remote Control Panel required	YES
(ix)	Marshalling kiosk required	YES
43.	Minimum Air core reactance of HV winding	20%
44.	Type of oil preservation	Air-cell type

2.1 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147.

2.2 PERFORMANCE

- i) Transformer shall be capable of withstanding for two seconds without

damage to any external short circuit.

- ii) The maximum flux density in any part of the core and yoke at rated MVA, Voltage and frequency, shall be 1.5 Tesla (maximum).
- iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.
- iv) The transformer may be operated continuously without danger on any particular tapping at the rated MVA \pm 12.5% of the voltage corresponding to the tapping.
- v) The thermal ability to withstand short circuit shall be demonstrated by calculation.
- vi) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. The Bidder shall submit the necessary Short Circuit Force Calculation with the offer.

2.3 DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

- a) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
- b) Assembly drawings of core, windings etc. and weights of main components / parts.
- c) Height of center line on HV and LV connectors of transformers from the rail top level.
- d) Dimensions of the largest part to be transported.
- e) GA drawings / details of various types of bushing
- f) Tap changing and Name Plate diagram
- g) Type test certificates of the quoted rating transformer.
- h) Illustrative & descriptive literature of the Transformer.
- i) The drawings and Type Test certificates of Tap Changer
- j) Maintenance and Operating Instructions.
- k) The Type Test certificates in complete shape for 'Lightning Impulse' and 'Short Circuit' Test and Temperature Rise Test

2.4 MISCELLANEOUS

- i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.
- ii) Foundation bolts for wheel locking devices of Transformer shall be

supplied by the Contractor.

2.5 DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

2.6 SCHEDULES

Any Schedule, if any, annexed to the specification shall be duly filled by the bidder separately.

2.7 NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of DISTCOM's name which will be intimated by OPTCL to the firm before hand.

The name plate shall also include :

- (i) The short circuit rating
- (ii) Measured no load current and no load losses at rated voltage and rated frequency
- (iii) Measured load losses at 75⁰ C (Normal Tap only)
- (iv) D.C resistance of each winding at 75⁰ C.

3.0 SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

		33 kV	11 kV
1	Frequency	50 Hz \pm 5%	50 Hz \pm 5%
2	Nominal system voltages	33 kV	11 kV
3	Maximum system voltages	36.3 kV	12 kV
4	Nominal short circuit level	AS per IS:2026	
5	Insulation levels (1.2/50 μ sec impulse withstand voltage)	170 kV (peak)	95kV (peak)
6	Power frequency with one minute withstand (wet & dry) voltage	70 kV(rms)	28 kV(rms)
7	Neutral earthing arrangements	-	Solidly earthed

4 CODES & STANDARDS

4.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

4.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

1	IS: 5	Colour for ready mixed paints & Enamels
2	IS: 325	Three Phase Induction Motors
3	IS: 335	New insulating oil for transformers, switch gears
4	IS: 1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
5	IS: 2026(Part I to IV	Power Transformer
6	IS: 2071	Method of high voltage testing
7	IS: 2099	High voltage porcelain bushings
8	IS: 2147	Degree of protection
9	IS: 2705	Current Transformers
10	IS: 3202	Code of practice for climate proofing of electrical equipment
11	IS: 3347	Dimensions for porcelain Transformer Bushings
12	IS: 3637	Gas operated relays
13	IS: 3639	Fittings and accessories for power Transformers
14	IS: 5561	Electric Power Connectors
15	IS: 6600/BS:CP' 10:0	Guide for loading of oil immersed Transformers
16	IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
17	IS 1002/1981 (Part – III)	Maintance of Transformer
18	C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

4.3 DRAWINGS

- a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.
 - i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
 - ii) Assembly drawings of core and winging and weights of main components / parts. In the Core-Coil assembly drawing , the following dimensions should be clearly mentioned:-

Core:- Window Height, Leg Centre, Core diameter, Grade & thickness of Core material, gross & net Core Cross-Sectional area, Watt loss per kg at the quoted flux density, VA per kg at the quoted flux density.

HV & LV Windings:- Conductor Size (both bare and insulated), Inside and Outside diameters, axial heights, type of windings, No. of spacers with sizes, No. of discs, No. of turns/disc, gap between discs ,clearance from top and bottom yoke, gap between windings, Size of the conductor for delta connection etc.
 - iii) Foundation plan showing loading on each wheel land jacking points with respect to Centre line of transformer.
 - iv) GA drawings details of bushing and terminal connectors.
 - v) Name plate drawing with terminal marking and connection diagrams.
 - vi) Wheel locking arrangement drawing.
 - vii) Transportation dimensions drawings.
 - viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
 - ix) Interconnection diagrams.
 - x) Over fluxing withstand time characteristic of transformer.
 - xi) GA drawing of marshalling box.
 - xii) Control scheme/wiring diagram of marshalling box.
 - xiii) Technical leaflets of major components and fittings.
 - xiv) As built drawings of schematics, wiring diagram etc.

- xv) Setting of oil temperature indicator, winding temperature indicator.
- xvi) Completed technical data sheets.
- xvii) Detail Drawings, Type Test Certificates including write-up of On-Load tap changing gear and its required accessories/equipments, wiring diagrams etc. as per this specification.
- xviii) HV conductor bushing.
- xix) Bushing Assembly.
- xx) Bi-metallic connector suitable for connection to 100 sq. mm up to 232 Sq.mm AAAC Conductor.

xxi) GA of LV cable Box.

xxii) Radiator type assembly

xxiii) Specific loss(watt/Kg. vs.Flux density), VA/Kg.vs.Flux density &B-H Graph for the offered HIB or better core material,to be used for the offered transformer

- b) All drawings, documents, technical data sheets and test certificates, results and calculations shall be furnished.
- c) Ampere –Turns Calculation at various locations and tapping positions of both LV and HV windings.

4.4 Any approval given to the detailed drawings by the OPTCL shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the OPTCL shall be general with overall responsibility with contractor.

5. GENERAL CONSTRUCTIONAL FEATURES

5.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.

5.2 Similar parts particularly removable ones shall be interchangeable.

5.3 Pipes and pipe fittings, screws, studs, nuts and bolts used for external Connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.

5.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.

5.5 Exposed parts shall not have pockets where water can collect.

5.6 Internal design of transformer shall ensure that air is not trapped in any location.

5.7 Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated.

- 5.8 Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.
- 5.9 All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified stands without injury.
- 5.10 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 5.11 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
- 5.12 Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

5.13 Painting

Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
 - b) Surface preparation prior to painting.
 - c) Mixing and thinning
 - d) Application of paints and the recommended limit on time intervals between coats.
 - e) Shelf life for storage.
- 5.13.1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 5.13.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of OPTCL.
- 5.13.1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

5.13.2 Cleaning and Surface Preparation

- 5.13.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
- 5.13.2.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning and Chemical cleaning by Seven tank process including Phosphating to the appropriate quality. The surface shall be treated by phosphating and dried in accordance with IS 6005(Code of practices for phosphating of Iron and

Steel). Immediately after Phosphating, surface shall be given two coats of high quality Zinc Chromate Primer.

5.13.2.3 The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

5.13.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

5.13.3 Protective Coating

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

5.13.4 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE . The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

5.13.5 Painting Procedure

5.13.5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.

5.13.5.2 Particular attention shall be paid to the manufacture's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

5.13.5.3 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.

5.13.5.4 Where the quality of film is impaired by excess film thickness,(wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25% . In all instances, where two or more coats of the same

paints are specified, such coatings may or may not be of contrasting colors.

- 5.13.5.5 Paint applied to items that are not to be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

5.13.6 Damages to Paints Work

- 5.13.6.1 Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.

- 5.13.6.2 Any damaged paint work shall be made as follows:

- a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
- b) A priming coat shall immediately be applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

- 5.13.6.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

5.13.7 Dry Film Thickness

- 5.13.7.1 To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.

- 5.13.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendations.

- 5.13.7.3 Particular attention must be paid to full film thickness at edges.

- 5.13.7.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl. No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness(Min)
1.	Liquid Paint			
	a) Zinc Chromate(Primer)	Out side	02	45 micron
	b) POLYURETHANE			
	(Finish Coat)	Out side	02	35 micron
	c) Hot Oil	inside	01	35 micron

6.0 DETAILED DESCRIPTION

6.1 Tank

- 6.1.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank shall be of welded construction. The transformer Tank shall be of rectangular Shape design(No elliptical shape design is allowed).
- 6.1.2 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bossed shall be provided for this purpose.
- 6.1.3 All beams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.
- 6.1.4 The main tank body of the transformer, excluding tap changing compartments and radiators ,shall be capable of withstanding pressure of 760mm of Hg. **The side Tank wall shall be of 6mm thickness (minimum) for 3.15MVA and 8mm(minimum) for 5MVA & 8MVA . The bottom and Top Plate of the Tank shall be of 8mm thickness (minimum) for 3.15MVA,10mm(minimum) for 5MVA &12mm.(minimum) for 8MVA.**
- 6.1.5 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- 6.1.6 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove-equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.
- 6.1.7 Suitable guides shall be provided for positioning the various parts during assemble or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

6.2 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water.

6.3 UNDER CARRIAGE

6.3.1 The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

6.4 CORE

6.4.1 Stage inspection for core construction shall be carried out by the Owner through a 3rd party agency as well as OPTCL / DISCOM.

6.4.2 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.

6.4.3 The core shall be constructed from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade or better grade with lamination thickness not more than 0.23mm to 0.27mm. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.

6.4.4 The bidder should offer the core for inspection starting from the destination port to enable OPTCL for deputing inspecting officers for detail verification as given below and approval by the OPTCL during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material:

The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core- cutting at the manufacturer's or it's sub-vendor's premises as per approved design drawing.

- a) Contract Order No. & Date.
- b) Invoice of the supplier
- c) Mills test certificate
- d) Packing list
- e) Bill of lading
- f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.

6.4.4 (B) For Transformer Manufacturer (TM), who has in-house core-cutting facility, the packed core coils shall be verified at their works as per followings along with witnessing of core- cutting.

- a) Purchase Order No. & Date ;
- b) No. of packed coils with Package Nos.
- c) Gross Weight.
- d) Net Weight :
- e) Port of loading.
- f) Port of Discharge ;
- g) Name of the Ocean Vessel :
- h) Grade & Thickness of Core Material :
- i) Any other information as mentioned on the body of packed coils.

6.4.4 (C) For those bidders, who have no in-house core-cutting facility, they should mention the names of at least three sub-vendors to whom they intend to assign their core-cutting. Such sub-vendors should have been approved by other Electricity Board / Electrical Utilities and accredited by some internationally recognized certification body like ISO- 9000 etc. to ensure that a minimum quality parameters & tolerance are maintained. The experience, the details of core-cutting facilities finishing & testing facilities etc. as available which such sub-vendors should be clearly out-lined in the bid

6.4.4 (D) On award of Contract the TM is to assign the core-cutting to such sub-vendors for which approval is to be given by the OPTCL.

6.4.5 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

6.4.6 The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.

6.4.7 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.

6.4.8 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

6.4.9 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

6.4.10 The core clamping structure shall be designed to minimize eddy current loss.

6.4.11 The framework and clamping arrangements shall be securely earthed.

6.4.12 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

6.4.13 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

6.4.14 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

6.4.15 The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assemble shall be so fixed in the tank that shifting will not occur during transport or short circuits.

6.4.16 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procedure to be mutually agreed) or by calculation.

6.5 **INTERNAL EARTHING**

6.5.1 All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.

6.5.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more the following methods:

- a) By connection through vertical tie-rods to the top structure.
- b) By direct metal to metal contact with the tank base.
- c) By a connection to the structure on the same side of the core as the main earth connection to the tank.

6.5.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

6.5.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

6.6 **WINDING:-**

6.6.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

6.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

- 6.6.3 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
- 6.6.4 Materials used in the insulation and assembly of the windings shall be insoluble, non catalytic and chemically inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.
- 6.6.5 Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
- 6.6.6 Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 6.6.7 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.
- 6.6.8 Terminals of all windings shall be brought out of the tank through bushings for external connections.
- 6.6.8.1 The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.
- 6.6.8.2 The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.
- 6.6.8.3 Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.
- 6.6.8.4 Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.
- 6.6.8.5 The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.
- 6.6.8.6 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.

6.6.8.7 Magnitude of impulse surges transferred from HV to LV windings by electro magnetic induction and capacitance coupling shall be limited to BIL of LV winding.

6.6.8.8 The current density adopted in all winding shall not exceed 2.4 A/mm². The total net conductor area should be arrived after deducting the area ,lost due to rounding off the sharp edges of the conductor , which is given below:-

0.21 mm ² up to a depth of 1.6 mm
0.36 mm ² mm up to a depth of 2.24 mm
0.55 mm ² up to a depth of 3.25 mm
0.86 mm ² above 3.25 mm

6.6.8.9 The finally compressed shrunk height of both HV and LV windings should be equal.

6.7 INSULATING OIL

6.7.1The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.

6.7.2The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.

6.7.3The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

6.7.4Transformer Oil-The contractor shall ensure that the Transformer oil furnished conforms to IS:335 including amendment,if any.

6.8 VALVES:-

i) Valves shall be of forged carbon steel upto 50mm size and of gun mental or of cast iron bodies with gun metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

ii) Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

iii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight

blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.

iv) Each transformer shall be provided with following valves on the tank:

- a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
- b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
- c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
- d) One 15mm air release plug.
- e) Valves between radiators and tank.

Drain and filter valves shall be suitable for applying vacuum as specified in this specification.

6.9 **ACCESSORIES:-**

6.9.1 **Bushing**

- i) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- ii) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- iii) Bushing shall be designed and tested to comply with the applicable standards.
- iv) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.
- v) Fittings made of steel or malleable iron shall be galvanized
- vi) Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.
- vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bush terminal and the OPTCL's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 50° C over an ambient of 50°C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- ix) Bushing of identical voltage rating shall be interchangeable.

x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.

xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.

6.9.2 Protection & Measuring Devices:-

i) Oil Conservator Tank

a) A conservator, complete with drain valve shall be provided in such a position, so as not to obstruct the electrical connections to the Transformer. The capacity of the conservator between highest and lowest visible levels shall be minimum of 7.5% of the total cold oil volume in the Transformer.

b) The conservator tank shall be bolted on its support of mounting to allow for its removal for cleaning/ repairing purposes.

c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

d) The silica gel breather shall have minimum quantity of silica gel as 1kg for every 3500Ltrs. of oil in the Tank. The container for the dehydrating agent shall be of transparent plastic of best quality, to be approved by OPTCL.

ii) Pressure Relief Device.

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contact shall be provided for alarm and tripping.

iii) Buchholz Relay

A double float type Buchholz relay shall be provided., Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

iv) Temperature Indicator

a) Oil Temperature Indicator (OTI)

The transformers shall be provided with a mercury contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1\%$ or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

b) **Winding Temperature indicator(WTI)**

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.

- i) Temperature sensing element.
- ii) Image Coil.
- iii) Mercury contacts.
- iv) Auxiliary CTS, If required to match the image coil, shall be furnished and mounted in the local control panel.
- v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and on for trip.
- vi) Calibration device.
- vii) Two number electrical contact each capable of operating at 5 A ac at 230 Volt supply.

7.9.3 Oil Preservation Equipment

6.9.3.1 :-

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

- i) Passage of air is through a dust filter & Silica gel.
- ii) Silica gel is isolated from atmosphere by an oil seal.
- iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- iv) Breather is mounted not more than 1400 mm above rail top level.

6.10 **MARSHALLING BOX:-**

i) Sheet steel, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, watertight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55 or better.

ii) The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a suitable sheet.

iii) The marshalling box shall accommodate the following equipment:

a) Temperature indicators.

b) Space for accommodating Control & Protection equipment in future for the cooling fan (for ONAF type cooling, may be provided in future).

c) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipments except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door (s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

iii) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

iv) All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

v) The control connection, wiring etc. shall be as per Clause 3.15 of this

6.11 **TAPCHANGER**

6.11.1 **ON-LOAD TAP-CHANGERS WITH REMOTE TAP CHANGE CONTROL**

Transformer of capacity **8MVA** shall be provided with an “**In-Tank**” or “**Flange Mounted**” Type on-load tap-changer connected to the high voltage winding. The on-load tap-changer shall be capable of withstanding the voltages described earlier and shall comply with the requirements of IEC-60214, latest

revision. Its tapping range, number of steps and tap positions shall be as specified.

On Load Tap Changer shall be sourced from reputed manufacturer(s) and it should be type tested as per relevant IEC60214 as given below and test methods shall be in full conformance to the procedures indicated in IEC60214

Sl.No.	IEC Reference	Test Description
1.	CI.5.2.1	Temperature rise of contacts.
2.	CI.5.2.2	Switching Tests
3.	CI.5.2.3	Short-circuit current Test.
4.	CI.5.2.4	Short-circuit current Test.
5.	CI.5.2.5	Mechanical tests.
6.	CI.5.2.6	Dielectric Tests

OLTC manufacturer shall conduct the following routine tests fully in compliance with IEC 60214 on every unit, as given below, before dispatch to assure the quality of the OLTC.OPTCL at its sole discretion may test-witness and inspect the Tap-Changers at the works of the OLTC manufacturer.

The following are the routine tests, to be carried out on each OLTC:-

Sl.No.	IEC Reference	Test Description
1.	CI.5.3.1	Mechanical Test.
2.	CI.5.3.2	Sequence test
3.	CI.5.3.3	Auxiliary circuits Insulation tests
4.	CI.5.3.4	Pressure test
5.	CI.5.3.4	Vacuum test

All the test reports shall be submitted to OPTCL for approval.

Adequate access for personnel shall be provided for inspection and maintenance. The guaranteed interval between maintenance periods for the diverter switch shall be 10 years or 50,000 operations. It shall not be possible for oil in the diverter switch compartment to come in contact with the oil in the main transformer tank.

The tap-changer shall be driven by a motor operated mechanism incorporating a stored energy device which shall ensure that once a change of tap begins it is completed and so shall ensure that the mechanism does not fail in an intermediate position on loss of the supply voltage to the motor. The motor shall be rated for 400/230V, 50 Hz and shall operate satisfactorily at any voltage between 85% and 110% of rated voltage.

A tap-changer mechanism box with hinged door and mounted on the

transformer tank at a convenient height shall contain all electrical and mechanical parts associated locally with control of the tap-changer. Remote tap-changer controls shall also be provided at a transformer control panel (one per transformer, to be supplied under this contract) in the control room.

Facilities for electrical raise and lower operation (Control switch or push button) as well as mechanical operation shall be provided as the tap-change mechanism box. An interlock shall be provided which shall interrupt the electric supply to the drive motor when the manual mechanical operating device is engaged. The motor drive control shall be such that on initiation of a tap-change operation by means of a control switch or push-button the tap-changer shall complete its movement from one service position to an adjacent one irrespective of whether or not the control switch or push button has been operated continuously during the running time or motor drive. Another operation shall only be possible when the previous operation has been completed, the control switch or push button has been released and the control system is again in the rest position.

The tap-changer arrangement shall be such that a command to raise tap-numbers shall result in an increase in the secondary voltage with constant voltage applied to the high voltage winding.

An under and over voltage monitoring relay fed with line voltage from the owner's voltage transformers on the low voltage side of the transformer and capable of being set in a continuously variable range from 90% to 115% normal voltage (110V) shall be used to give visual and audible signals at the remote tap change control panel if the LV voltage lies above or below preset values.

Limit switches shall be provided to prevent over-running of the tap-change mechanism. These shall be directly connected in the motor circuit. In addition mechanical end stops shall be fitted to prevent over-running of the mechanism under any conditions. A counter shall be provided to indicate the number of tap-change operations that have been taken place.

A mechanical tap-position indicator shall be provided and it shall be visible from ground level through a window in the door of the mechanism box. Position transmitter e.g. dial switches shall be provided to:

- a. Signal tap position to the control cabinet in the control room.
- b. Signal "out of step" under parallel operating conditions.

A Remote/Local switch shall be provided at the mechanism box to select either remote or local operation. When this switch is turned to the Remote position control shall be passed to the control cabinet in the control room. It should be possible to use only one control, i.e. Local or Remote.

It shall be possible to operate a transformer tap-changer independently or in parallel with the tap-changers of other similar transformers in the same substation in either a “master” or “follower” mode. In addition, when operating independently or in parallel in the master mode, it shall be possible to have manual operation by means of control switch, push button or, (in future) automatic operation by means of an automatic voltage regulating relay. Contacts shall be provided for future SCADA control of the tap-changer and for reporting of the tap position and mode of control to the SCADA system. The paralleling scheme shall use the in- step principle and shall have provision for operating singly or in parallel in any combination. It shall be possible for any transformer in a group to be selected as either the master or follower for that group when operating in parallel. Each transformer control panel shall therefore have a manual/automatic control switch or push buttons, independent/master/follower control switch or push buttons as well as “raise” and lower” control switches or push buttons. Interlock shall be provided to avoid independent operation when the transformers are running in parallel. There should not be any out-of-step during such operation.

The control scheme shall be capable of extension to cater for the total number of transformers to be installed in any future development of the substation. The control mode selected shall be indicated on the front of the control cabinet.

Each transformer shall have a miniature circuit breaker (MCB) on the AC distribution cabinet through which the 400/230V, 50 Hz supply to its tap-changer and temperature controls is passed. Separate MCB's shall be provided at the mechanism box for protection of the motor and control circuits. The control circuits shall operate at 110V single phase, to be supplied from a transformer having a ratio of 230/55-0-55 V, with the center point earthed through a removable link mounted in the marshalling box or tap-changer mechanism box.

Each tap-changer mechanism box shall be fitted with an anti-condensation space heater (230V AC) controlled by a humidistat with variable range. A lamp for illumination purposes controlled by a door switch shall be provided. Solar gain can give rise to high temperature within a mechanism box. Adequate

ventilation shall be provided to ensure that all equipment contained therein shall operate satisfactorily under these conditions.

A terminal block with terminals rated for 10 A continuous current, 650V grade of moulded insulating materials shall be provided for panel wiring and external connection.

Ten percent spare terminals shall be provided in each mechanism box.

The tap changer mechanism box shall be outdoor, weatherproof type, dust, vermin and damp proof with a degree of protection of IP54 of IEC 529 or IS 13947 equivalent.

6.11.2 **Transformer Tap Change Control Panel:-**

The indoor panel suitable for installation in the owner's control room mentioned above shall contain.

- Raise and Lower push buttons or switch.
- Independent / master / follower selector switch.
- Remote tap position indicator.
- Necessary audible & visual alarms.
- Out of step relay with two spare contacts (2 NO + 2 NC)

In addition to the above the Transformer tap change control panel shall have an audible and visual annunciation system for the following trips and alarms.

Oil temperature alarm
Oil temperature trip
Winding temperature alarm
Winding temperature trip
Buchholz alarm
Buchholz trip
Surge relay trip(OLTC gear)
Low oil level alarm
Tap changer out-of-step alarm
Failure of D.C supply alarm

Two spare windows shall be supplied on each panel

Indicating lamps shall be panel mounted type with rear terminal connections. Lamps shall be provided with series connected resistors preferably built within

the lamp assembly. Lamps shall have screwed translucent lamp covers to diffuse light and shall be continuously rated for 120 percent of the 24 volt DC supply from a power pack having desired capacity. The 'DC supply failure' lamp shall operate from the AC supply and be rated for 230 Volt AC. The wattage of the lamps shall be not more than five watts. Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel.

The Annunciation scheme with facia windows and alarm bells shall work as follows.

Annunciation scheme functions

Incident	Alarm Bell	Facia Window
Fault occurrence	Ringling	Light flashing
Sound cancel	Off	Light flashing
Acknowledge	Off	Steady light
Fault cleared and reset	Off	Clear
Lamp test	Off	Steady

Any new annunciation operating after the operation of the 'sound cancel' shall cause audible and visual alarm even if the process of acknowledging the previous alarm is going on or has yet to be carried out. Resetting facilities for the flasher and audible alarm circuits of the annunciator shall be provided, and provision shall be made for switching off the entire annunciation system. Two spare windows shall be provided.

The control and relay panel shall be metal clad, dust, moisture, rodent and vermin proof with degree of protection not less than IP 41 specified in IEC :529/ IS : 13947. Panels shall have folded construction and be of unit type. Each panel shall be a free standing structure, independent floor mounting type and shall be manufactured from cold rolled sheet steel of thickness not less than 2.5 mm. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation, installation and service. The panel shall be painted as specified in the clause on "painting" in the specification.

Design, material selection and workmanship shall be such as to result in neat appearance inside and outside with no welds, rivets or bolt ends apparent from outside, with all exterior surfaces even and smooth. The equipment on the front of the panel shall be matched to give neat uniform appearance.

All doors and removable covers shall be gasketed all round with neoprene bonded gaskets, Ventilating louvers shall be provided with screens and filters. The screen shall be made of non corroding metal like brass or galvanized iron wire mesh.

The transformer tap change control panel shall be supplied with all necessary internal wiring, terminal blocks, relays and alarms to provide the above listed alarm and trip functions.

Panel wiring shall be suitably bunched and clamped for neat appearance. The conductors used for wiring purpose shall be PVC insulated 650 Volt grade semi-flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC : 227 or IS : 1554. The wiring shall be securely supported and taken through PVC troughs. All panel wiring shall be capable of withstanding a voltage of 2 KV AC 50 Hz for one minute.

Terminal blocks of brass studs rated for 10 amps continuous current, 650 volt DC grade covered by moulded insulating materials with adequate electrical clearance shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare conductor with insulating sleeves at the ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire terminations provided with numbered ferrules for identification. All numbering and marking including those in wiring diagrams shall follow the guidelines provided in IS : 11353. Ten percent spare terminals shall be provided.

A separate removable gland plate shall be provided at the bottom of each panel

for entry of PVC insulated control and auxiliary power cables in the cabinet. At least five electroplated brass cable glands of approved sizes with shrouds shall be provided in the gland plate for these cables. Provision shall be made for earthing of the cable armours in the glands.

6.11.3 OFF LOAD TAP CHANGER (For 3.15 and 5 MVA transformers)

- i The transformers shall be provided with Off-load Taps
- ii The Transformer with off-load tap changing gear shall have taps ranging from +5% to -15% in 8 equal steps of 2.5% each on HV winding for voltage variation
- iii The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position

6.12

FITTINGS AND ACCESSORIES:-

The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
- ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
- iii) Prismatic/ toughened glass oil level gauge.
- iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.

- vii) Air release plugs in the top cover.
- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have three set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
- x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.
- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to Owner's grounding strip.
- xx) Bi-directional flagged rollers with locking and bolting device.
- xxi) Marshalling Box (MB)
- xxii) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxiii) Cooling Accessories :
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top

- Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors :
 - xxiv) Terminal marking plates for Current Transformer and Main Transformer
 - xxv) On- Load Tap Changer
 - xxvi) Oil Preservation Equipment
 - xxvii) Oil Temperature indicator
- Note :**
- (i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.
 - (ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

vi) The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
- ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
- iii) Prismatic/ toughened glass oil level gauge.
- iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.
- vii) Air release plugs in the top cover.

- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
- x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.
- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to grounding strip of the S/s.
- xx) Bi-directional flagged rollers with locking and bolting device.
- xxi) Marshalling Box (MB)
- xxii) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxiii) Cooling Accessories:
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors :

- xxiv) Terminal marking plates for Current Transformer and Main Transformer
- xxv) On-Load Tap Changing Gear with all necessary equipments and control mechanism for both local and remote operation
- xxvi) Oil Preservation Equipment
- xxvii) Oil Temperature indicator

Note : (i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer including tap-changing by On-Load Tap changing Gear are deemed to be included in the quoted price of the transformer.

(ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

6.13 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES:-

- i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.
- ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.
- iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.
- iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
- v) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm
- vii) All wires on panels and all multi-core cables shall have ferrules, for easy

identifications, which bear the same number at both ends, as indicated in the relevant drawing.

- viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.
- ix) The same ferrule number shall not be used on wires in different circuits on the same panels.
- x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.
- xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.
- xii) All circuits, in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.
- xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green colour insulation for earth connections.
- xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
- xv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
- xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails .
- xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs

should have provision to insert banana plugs and with isolating links.

- xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
- xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
- xx) To avoid condensation in the Marshalling Box, a space heater shall be provided with an MCB and thermostat.
- xxi) Suitable MV, CFL light shall be provided in the Marshalling Box for lightning purpose.

6.14 RADIO INTERFERENCE AND NOISE LEVEL:-

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimise interference with communication circuits. Transformer noise level when energised at normal voltage and frequency shall be as per NEMA stipulations.

7.0 INSPECTION AND TESTING

- (i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. An indicative in inspection is given under Clause No. 4.1. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the OPTCL.
- (ii) The contractor shall carry out type tests and routine tests on the transformers. Only one no of transformer of each rating will be subjected to type tests as per relevant IEC/IS in CPRI presence of authorized Engineer(s) of OPTCL. The charges for conducting each of type tests shall be included in the bid price and no separate type test charges shall be paid. Front page of the Type test report of same voltage class, same ratio (33/11kV) & rating (3.15MVA or higher) duly signed by the bidder is required to be scanned & upload along with the bid. However, designed transformer as per tender specification parameters to be made by the contractor at his cost. Type test to be done designwise not packagewise.
- (iii) The pre-shipment checks shall also be carried out by the contractor.
- (iv) The requirements on site tests are as listed in the specifications.
- (v) Certified test report and oscillograms shall be furnished to the OPTCL for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the OPTCL's evaluations of the tests without any extra charges to OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

- (vi) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.
- (vii) OPTCL at its discretion may use its power analyser or the power analyser of authorized testing agency for determination of no load loss, no load current, load loss and % Impedance at the works of the manufacturer and the concerned stores/Testing Laboratory of OPTCL/Any other Government approved laboratory.

8.0 INSPECTION

i) Tank and Conservator

- a) Inspection of major weld.
- b) Crack detection of major strength weld seams by dye penetration test.
- c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check.
- d) Leakage test of the conservator.

ii) Core

- a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings.
- c) Check on the amount of burrs.
- d) Visual and dimensional check during assembly stage.
- e) Check on completed core for measurement of iron loss, determination of maximum flux density. (Determination of gross and net cross sectional area of the core & no. of turns/Phase.)
- f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- g) High voltage DC test (2 KV for one minute) between core and clamps.

iii) Insulating Material

- a) Sample check for physical properties of materials.
- b) Check for dielectric strength
- c) Check for the reaction of hot oil on insulating materials.

iv) Winding

- a) Sample check on winding conductor for mechanical and electrical conductivity.
- b) Visual and dimensional checks on conductor for scratches, dent mark etc.
- c) Sample check on insulating paper for PH value, electric strength.
- d) Check for the bonding of the insulating paper with conductor.

- e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- f) Check for absence of short circuit between parallel strands.

v) Checks Before Drying Process

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulating test for core earthing.

vi) Check During Drying Process

- a) Measurement and recording of temperature and drying time during vacuum treatment.
- b) Check for completeness of drying

vii) Assembled Transformer

- a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- b) Jacking test on the assembled Transformer.

viii) Oil

All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.

ix) Test Report for bought out items

The contractor shall submit the test reports for all bought out / sub contracted items for approval.

- a) Buchholz relay
- b) Sudden pressure rise relay on Main Tank
- c) Winding temperature indicators (for TX capacity 5 MVA)
- d) Oil temperature indicators
- e) Bushings
- f) Bushing current transformers in neutral (If Provided)
- g) Marshalling box
- h) Tap changer
- i) Any other item required to complete the works.
- j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS . If such requirement is purchased by the contractor on a

sub-contract, he shall have them tested to comply with these requirements.

8.1 **FACTORY TESTS**

- i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.
- ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
- iii) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- iv) Following additional routine tests shall also be carried out on each transformer:
 - a) Magnetic Circuit Test
Each core shall be tested for 1 minute at 2000 Volt DC
 - b) Oil leakage test on transformer

8.2 **Type Tests:-**

The transformer shall be subjected to the following type tests particularly Short circuit and Impulse withstand tests at CPRI. Before conducting the short circuit test and Impulse test, the firm will offer for both stage inspection and final inspection of the transformer by through a 3rd party agency as well as OPTCL / DISCOM at the manufacturer's works. If the transformer complies to the specification and offered technical parameters, the transformer will be sealed by authorized engineer(s) of OPTCL and thereafter the transformer can be transported to CPRI for required type tests in presence of OPTCL's authorized representative(s) who will verify the seal & allow for conducting the type tests.

The Type Tests shall include:-

- (1) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (2) Measurement of Zero sequence impedance.
- (3) Temperature Rise Test
- (4) Short Circuit Test
- (5) Tank Vacuum test
- (6) Tank Pressure Test
- (7) Lightning impulse withstand test for line and neutral terminal.

- (8) Measurement of acoustic noise level.

8.3 STAGE INSPECTION:-

The supplier shall offer the core, windings and tank of each transformer for inspection by a 3rd party agency as well as OPTCL representative(s). During stage Inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the OPTCL. No. of turns is to be determined by wrapping known No. of turns across LV winding and determining the turns ratio by ratio meter.

8.4 Routine Tests:-

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following :

- (i) Measurement of winding DC resistance.
- (ii) Voltage ratio on each tapping and check of voltage vector relationship.
- (iii) Impedance voltage at all tapings.
- (iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (v) Measurement of Load losses at normal tap and extreme taps.
- (vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 121 % of rated voltage in steps.
- (vii) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R_{60} / R_{15}) and polarization index i.e Insulation Resistance for 10 minutes and one minute ($R_{10\text{ mt}} / R_{1\text{ mt}}$).
- (viii) Induced over voltage withstand test.
- (ix) Separate source voltage withstand test.
- (x) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (xi) Measurement of zero sequence impedance
- (xii) Tests on On- Load tap changer (fully assembled on transformer) as per IEC : 214/ 1976 and BS: 4571/ 1970.

- (xii) Auxiliary circuit tests
- (xiv) Oil BDV tests
- (xv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.
- (xvi) Magnetic balance test
- (xvii) Leakage test.

Six (6) set of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and OPTCL's evaluation of the tests without charge to the OPTCL.

8.5 TANK TESTS

a) Oil leakage Test :

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of 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/ m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the OPTCL, one transformer tank of each size together with its radiator, conservator vessel and other fittings 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.

c) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

8.6 PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS

- i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
- ii) Check for proper provision of bracing to arrest the movement of core and

winding assembly inside the tank.

- iii) Gas tightness test to conform tightness.

8.7 INSPECTION AND TESTING AT SITE

The Engineer authorized from OPTCL along with the contractor's site engineer shall carry out detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

8.7.1 Receipt and Storage Checks

- i) Check and record conditions of each package visible parts of the transformers etc for any damage.
- ii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.

8.2.8 Installation Checks

- i) Inspection and performance testing of accessories like tap changers etc.
- ii) Check choking of the tubes of radiators
- iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.
- iv) Check the whole assembly for tightness, general appearance etc.
- v) Oil leakage tests.

8.7.2 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) Dry out test
- ii) Megger Test
- iii) DC Resistance measurement of windings
- iv) Ratio test on all taps
- v) Phase relationship test (Vector grouping test)
- vi) Buchholz relay alarm & surge operation test
- vii) Low oil level (in conservator) alarm
- viii) Temperature Indicators
- ix) Marshalling kiosk
- x) Protective relays

x i) Magnetising current

x i i) Tests on OLTC

8.7.3 The following additional checks shall be made :

- i) All oil valves are in correct position closed or opened as required
- ii) All air pocket are cleared.
- iii) Thermometer pockets are filled with oil.
- iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
- v) Earthing connections are made.
- vi) Colour of Silica gel is blue.
- vii) Bushing arcing horn is set correctly and gap distance is recorded.
- Viii) C T polarity and ratio is correct.

9.0 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

- i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and $\pm 10\%$ corresponding to the voltage of the tapping
- ii) Radio interference and Noise Level
- iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

9.1 FAULT CONDITIONS

- a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth
- b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS : 2026.
- c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

Certified test report and oscillograms shall be furnished to the OPTCL for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the OPTCL's evaluations of the tests without any extra charges to the OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.

10.0 LOSSES:-

Sl.No	Transformer Rating	Maximum No-Load Loss in KW at rated voltage & frequency	Maximum Load Loss in KW at 75°C at normal tap position & rated frequency
1	33/11 KV, 3.15 MVA	3.0	17
2	33/11 KV, 5 MVA	3.6	21
3	33/11 KV, 8 MVA	4.5	38

N.B : There shall be no positive tolerance to above losses. Capitalization of losses shall not be factored in the comparative statement for selection of vendors.

11.0 SPARE PARTS:-

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the OPTCL to fabricate or procure spare parts from other sources.

Mandatory Spare Parts

The suppliers shall provide the following mandatory spare parts for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs –Each 2 Nos
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

12.0 INSTRUCTION MANUAL:-

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

- a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- b) Detailed dimensions, assembly and description of all auxiliaries.

- c) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required for carrying out overhauling operation at site.
- d) Salient technical particulars of the transformer.
- e) Copies of all final approved drawings.
- f) Detailed O&M instructions with periodical check lists and Performa etc.

13.0 COMPLETENESS OF EQUIPMENT:-

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without any extra charge. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the OPTCL under any circumstances.

13.1 TOOLS AND TACKLES:-

All the necessary tools and tackles required for normal operation & maintenance of the transformers shall be supplied by the Contractor.

13.2 COMMISSIONING:-

The equipments shall be commissioned as per CBIP manual, IS: 10028 and manufacturer's recommendations. All the related drawings and manuals shall be pre-requisite for release of final payment.

ANNEXURE – I

(Technical Data Schedule for 3.15MVA, 5MVA & 8 MVA,33/11kV Power Transformers)

Sl. No.	Description	Bidder's offer
1.	Name and address of the Manufacturer	
a)	Transformer	
b)	HV & LV Bushings	
c)	Bimetallic connectors	
d)	Transformer Oil	
e)	On load tap changer	
f)	Instruments	
g)	Neutral Bushing CTs	
2.	Service (Indoor / Outdoor)	
3.	Normal continuous rating in KVA under site conditions at all taps :	
a)	HV winding (KVA)	
b)	LV winding (KVA)	
4.	Rated Voltage	
a)	HV winding (KV)	
b)	LV winding (KV)	
5.	Rated frequency (Hz)	
6.	No. of phases	
7.	Type of transformer	
8.	Connections	
a)	HV winding	
b)	LV winding	
9.	Connections symbols	
	HV – LV	
10.	Tappings	
a)	Range	
b)	Number of steps	
c)	Position of tapping on HT winding for high voltage variation	
11.	Reference ambient temperatures	
a)	Maximum ambient air temperature ($^{\circ}\text{C}$)	
b)	Maximum daily average ambient temperature ($^{\circ}\text{C}$)	
c)	Minimum ambient air temperature ($^{\circ}\text{C}$)	
d)	Maximum yearly weighted average ambient temperature ($^{\circ}\text{C}$)	
12.	Maximum temperature rise over ambient temperature	
a)	Top oil by thermometer ($^{\circ}\text{C}$)	
b)	HV & LV windings by resistance measurement ($^{\circ}\text{C}$)	
Sl. No.	Description	Bidder's offer
c)	Hot Spot Temperature rise of windings($^{\circ}\text{C}$)	
d)	Limit for hot spot temperature for which the transformer is designed ($^{\circ}\text{C}$)	
e)	Temperature gradient between windings and oil ($^{\circ}\text{C}$)	
f)	Type of maximum winding temperature indicator ($^{\circ}\text{C}$)	

13.	Voltage to earth for which the star point will be insulated	
14.	Cooling type	
15.	Losses	
a)	No-Load loss at rated voltage & rated frequency (KW)	
b)	Load loss at rated current at Normal Tap at 75 ⁰ C (KW)	
16.	Max. Current density in winding at rated current for normal tap position	
a)	HV winding (Amps/ sq.mm.)	
b)	LV winding (Amps / sq.mm.)	
17.	Impedance voltage at rated current ,rated frequency and at 75 ⁰ C expressed as percentage of rated voltage at :-	
a)	Principal (normal) tap (%)	
b)	Highest tap (%)	
c)	Lowest tap (%)	
18.	Reactance at rated current & frequency as percentage of rated voltage at:	
a)	Principal (normal) tap	
b)	Highest Tap	
c)	Lowest Tap	
19.	Resistance at 75 ⁰ C	
a)	H.V. winding at normal tap position	
b)	L.V. winding	
c)	Resistance voltage drop at 75 ⁰ C winding temperature expressed as percent of rated voltage (%)	
	i) Principal/ normal tap	
	ii) Highest tap	
	iii) Lowest tap	
20.	Insulation level	
a)	Separate source power frequency voltage withstand	
	i) HV winding (KV rms)	
	ii) LV winding (KV rms)	
b)	Induced over voltage withstand	
	i) HV winding (KV rms)	
	ii) LV winding (KV rms)	
c)	Full wave lightning impulse withstand voltage	
Sl. No.	Description	Bidder's offer
	i) HV winding (KV peak)	
d)	Power frequency high voltage tests	
	i) Test voltage for one minute withstand test on high voltage windings (induced)	
	ii) Test voltage for one minute withstand test on low voltage windings	
	iii) Test voltage for one minute withstand test on neutral end of low voltage windings	
e)	Lightning impulse withstand tests	
	i) Impulse test on high voltage winding 1.2/50 μ sec full wave withstand (KV peak)	

	ii) Impulse test on low voltage winding 1.2/50 μ sec full wave withstand (KV peak)	
	iii) Wave form for impulse test	
21.	No load current, no load loss, no load power factor at normal ratio and frequency (Amp/ KW/ P.F.)	
a)	10 percent of rated voltage	
b)	25 percent of rated voltage	
c)	50 percent of rated voltage	
d)	85 percent of rated voltage	
e)	100 percent of rated voltage	
f)	105 percent of rated voltage	
g)	110 percent of rated voltage	
h)	112.5 percent of rated voltage	
i)	115 percent of rated voltage	
j)	120 percent of rated voltage	
k)	121 percent of rated voltage	
22.	Efficiency at 75° C at unity power factor	
a)	Full load	
b)	75% load	
c)	50% load	
d)	25% load	
23(a)	The minimum percentage of load at which the transformer will run at maximum efficiency (%)	
b)	Maximum efficiency of the transformer	
24.	Regulation at full load at 75° C	
a)	At unity power factor (%)	
b)	At 0.8 power factor (lagging) (%)	
25.	Core data	
a)	Grade of core material used	
b)	Thickness of core plate lamination (mm)	
c)	Whether core laminations are of HIB cold rolled grain oriented	
Sl. No.	Description	Bidder's offer
d)	Details of oil ducts in core, if any	
	i) Whether in the plane & at right angle to the plane of winding	
	ii) Across the plane of lamination	
e)	i) Insulation of core lamination	
	ii) Insulation of core plates	
	iii) Type of core joints(Mitred or Mitred Step-lap)	
26.	Flux density	
a)	Designed maximum flux density at rated voltage and rated frequency (Tesla)	
b)	Designed maximum operating flux density which the transformer can withstand for one minute at normal tap (Tesla)	
c)	Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap (Tesla)	
27.	Inter-Tap insulation	
a)	Extent of extreme end turns reinforcement	
b)	Extent of end turns reinforcement	
c)	Extent of turn adjacent to tapping reinforced	
d)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (a)	

e)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)	
f)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)	
28.	Windings:	
a)	Material	
b)	Type of windings:	
	i) HV windings	
	ii) LV windings	
c)	Insulation of HV windings	
d)	Insulation of LV windings	
e)	Insulation between HV & LV windings	
29.	Continuous rating under following conditions:	
a)	At 40°C ambient air temp. at site	
b)	At 30°C ambient air temp. at site	
c)	At 20°C ambient air temp. at site	
30.	Transformer Tank	
a)	Material	
b)	Thickness	
	- Top	
	- Sides	
	- Bottom	
c)	Details of painting	
	- Inner surface	
	- Outer surface	
31.	Dimensions of 3 phase transformers:	
Sl. No.	Description	Bidder's offer
a)	Max. Height to top of bushings (mm)	
b)	Over-all length (mm)	
c)	Over-all breadth (mm)	
32.	Weight data of transformer components : (Tolerance + 5%) (approximate values not allowed)	
a)	Core excluding clamping (Kg)	
b)	Core with clamping (Kg)	
c)	HV winding insulated conductor (Kg)	
d)	LV winding Insulated conductor (Kg)	
e)	Coils with insulation (Kg.)	
f)	Core and windings (Kg)	
g)	Weight of steel (Kg)	
h)	Fittings and accessories (Kg)	
i)	Oil required for first filling including 10% extra (ltrs / Kg)	
	1. Oil in main tank (Ltrs)	
	2. Oil in the conservator (Ltrs)	
	3. Oil in the radiators (Ltrs)	
	4. Oil in the OLTC (Ltrs.)	
	5. Overall total quantity of oil with 10% extra oil for first filling (ltrs / Kg)	
j)	1. Transportation weight excluding accessories (Kg)	
	2. Shipping details	
	i) Weight of heaviest package (Kg.)	
	ii) Dimension of largest package (Kg)	

k)	Untanking weight (Kg)	
l)	Total weight of transformer with oil and fittings (Kg)	
33.	Bushing data :	
a)	Type of bushing insulator	
	i) HV	
	ii) LV	
	iii) Neutral	
b)	Material of bushing (inner part / outer part)	
c)	Weight of bushing insulator (Kg.)	
d)	Quantity of oil in one bushing (lt.)	
e)	Minimum dry withstand & flash over power frequency voltage of bushing (KV)	
f)	Minimum wet withstand & flash over power frequency voltage of bushing (KV)	
g)	Minimum withstand & flashover impulse level (KV)	
h)	Voltage rating (KV)	
i)	Current rating (Amps.)	
j)	Thermal Short Time current & Duration	
Sl. No.	Description	Bidder's offer
k)	Rated Dynamic current & its duration	
l)	Cantilever with stand loading	
m)	Clearance in oil	
	- phase to phase (mm)	
	- phase to earth (mm)	
n)	Creepage distance in oil & air (mm)	
o)	Minimum level of immersing / medium (oil) (mm)	
p)	Maximum pressure of immersing medium (oil) Kg/ cm ²	
q)	Free space required at top for removal of bushings (mm)	
r)	Angle of mounting	
34.	Details of CT to be provided in the neutral for REF protection.	
a)	Outdoor bushing type	
b)	No. of cores and their function	
c)	Location (Line / Neutral)	
d)	Current rating for various cores (Primary / Secondary)	
e)	VA burden / Knee Point voltage (Core wise)	
f)	Magnetising current at half knee point voltage. (mA)	
g)	Classification (PS class) core wise	
h)	Test voltage	
i)	Construction details	
35.	Conservator (Main Transformer and OLTC)	
a)	Total volume of the Conservator (Cub mtr / Ltr.)	
b)	Volume of the conservator between the highest and lowest level (Cubic mtr. / Ltrs)	
36.	Calculated time constants for natural cooling	
37.	Type of axial coil supports :	
a)	HV winding	
b)	LV winding	
38.	Details of On Load tap changer	

a)	Make	
b)	Type	
c)	Rating	
	i) Rated Voltage	
	ii) Rated current	
	iii) Step voltage	
	iv) Number of steps	
	v) Rated Short Circuit Current	
Sl. No.	Description	Bidder's offer
d)	Whether Diverter switch provided with gas vent and buchholz relay (Yes / No)	
e)	Whether a separate oil surge relay with trip contacts provided (Yes / No)	
f)	Pressure relief valve	
g)	Details of motor device unit housed in kiosk / mounted on tap changer	
h)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers are running in parallel and independent control when in independent operation.	
i)	Details of equipment in the OLTC kiosk	
j)	Details of OLTC panels	
	i) automatic tap changer relay	
	ii) literature of all the relays	
	iii) dimensions of OLTC, Panel L x B x H	
	iv) thickness of sheet	
	v) degree of protection	
	vi) details of equipment supplied	
39.	Dispatch details :	
a)	Approx. mass of heaviest Package (Kg)	
b)	Approx. dimensions of largest Package	
	i) Length (mm)	
	ii) Breadth (mm)	
	iii) Height (mm)	
40.	Un-tanking height (mm)	
41.	Bimetallic connectors HV / LV	
a)	Normal current rating (A)	
b)	Short time current rating (A)	
c)	Tensile strength (Kg)	
d)	Maximum temperature limit	
e)	Dimensional sketch enclosed indicating tolerances (Yes/No)	
f)	Minimum clearance (mm)	
	- Phase to phase	
	- Phase to Earth	
42.	CORE ASSEMBLY :-	
a)	Core diameter (mm)	
b)	Core window height (mm)	
c)	Core leg centre (mm)	
d)	Gross core cross – sectional area (m ²)	
e)	Total height of core (mm)	

f)	Details of top end frame	
g)	Details of Bottom end frame	
Sl. No.	Description	Bidder's offer
h)	Details of clamp plate (material, thickness, insulation)	
i)	Total core weight (Kg)	
j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency) (KW)	
k)	Core stacking factor	
l)	Net core area (Sq.m)	
m)	Margin towards corner joints, cross-fluxing, dielectric loss (KW)	
n)	Total core loss at rated voltage and rated frequency (KW)	
o)	Describe location / method of core grounding	
p)	Details of core- belting	
	i) Material , grade and type	
	ii) Width	
	iii) Thickness	
	iv) Fixing method	
43.	DETAILS OF WINDING	
a)	Type of winding	
b)	Material of the winding conductor	
c)	Maximum current density of windings at rated current and conductor area	
d)	Whether windings are pre-shrunk ?	
e)	Whether adjustable coil clamps are provided for HV and LV windings ?	
f)	Whether steel rings are used for the windings ? If so, whether these are split ?	
g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings ?	
h)	Winding Insulation (Type & Class)	
i)	Insulating material , used for	
	i) H.V winding	
	ii) LV winding	
	iii) Tapping connection	
j)	Insulating material used between	
	i) L.V and H.V winding	
	ii) Core & L.V winding	
k)	H.V to H.V winding between phases	
l)	Type of axial supports	
	i) H.V winding	
	ii) L.V winding	
m)	Type of radial supports	
	i) H.V winding	
	ii) L.V winding	
n)	Maximum allowable torque on coil clamping bolts	
Sl. No.	Description	Bidder's offer
o)	Clamping ring details	
	i) Thickness of ring mm	
	ii) Diameter of ring mm	

	iii) No. & size of pressure screw	
p)	Bare conductor size (mm)	
	i) HV	
	ii) LV	
q)	Insulated conductor size (mm)	
	i) HV	
	ii) LV	
r)	No. of conductor in parallel (Nos.)	
	i) HV	
	ii) LV	
s)	No. of turns / phase	
	i) HV	
	ii) LV	
t)	No. of discs / phase	
	i) HV	
	ii) LV	
u)	No. of turns / Disc	
	i) HV	
	ii) LV	
v)	Gap between discs (mm)	
	i) HV	
	ii) LV	
w)	Inside diameter (mm)	
	i) HV	
	ii) LV	
x)	Outside diameter (mm)	
	i) HV	
	ii) LV	
y)	Axial height after shrinkage (mm)	
	i) HV	
	ii) LV	
z)	<u>D.C Resistance</u>	
i)	L.V winding at 75 ⁰ C (Ohms)	
ii)	H.V winding at normal tap at 75 ⁰ C (Ohms)	
iii)	H.V winding at highest tap at 75 ⁰ C (Ohms)	
iv)	H.V winding at lowest tap at 75 ⁰ C (Ohms)	
Sl. No.	Description	Bidder's offer
v)	Total I ² R losses at 75 ⁰ C for normal tap (KW)	
vi)	Total I ² R losses at 75 ⁰ C for highest tap (KW)	
vii)	Total I ² R losses at 75 ⁰ C for lowest tap (KW)	
viii)	Stray losses including eddy current losses in winding at 75 ⁰ C (KW)	
	a) Normal tap position	
	b) Highest tap position	
	c) Lowest tap position	
	d) Any special measures, taken to reduce eddy current losses and stray losses. Mention in details	

ix)	Load losses at 75 ⁰ C (I ² R + Stray)	
	a) Normal tap position (KW)	
	b) Highest tap position (KW)	
	c) Lowest tap position (KW)	
x)	Details of special arrangement, provided to improve surge voltage distribution in the windings.	
44.	<u>DETAILS OF TANK :</u>	
a)	Material of Transformer tank	
b)	Type of tank	
c)	Thickness of sheet (No approximate value to be mentioned)	
	i) Sides (mm)	
	ii) Bottom (mm)	
	iii) Cover (mm)	
	iv) Radiators (mm)	
d)	Inside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
	ii) Breadth (mm)	
	iii) Height (mm)	
e)	Outside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
	ii) Breadth (mm)	
	iii) Height (mm)	
f)	Vacuum recommended for hot oil circulation (torr / mm of Hg)	
g)	Vacuum to be maintained during oil filling in transformer tank (torr / mm of Hg)	
h)	Vacuum to which the tank can be subjected without distortion (torr / mm of Hg)	
i)	No. of bi-directional wheels provided	
j)	Track gauge required for the wheels	
	i) Transverse axis	
Sl. No.	Description	Bidder's offer
	ii) Longitudinal axis	
k)	Type and make of pressure relief device and minimum pressure at which it operates (Kpa)	
45.	<u>CONSERVATOR :-</u>	
a)	Thickness of sheet (mm)	
b)	Size (Dia x length) (mm)	
c)	Total volume (Litres)	
d)	Volume between the highest and lowest visible oil levels (Litres)	

CHAPTER – E5- 2

TECHNICAL SPECIFICATION FOR 100KVA, 33/0.433kV STATION TRANSFORMER

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OF
100KVA, 33/0.433kV STATION TRANSFORMER

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TECHNICAL SPECIFICATION FOR OUTDOOR TYPE 100 KVA, 33/.433KV STATION TRANSFORMER

1.0 SCOPE:

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3 phase **100 KVA, 33kV/ 0.433KV** station transformer for outdoor use.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the Owner, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

1.3 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.

1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

2.0 STANDARD RATINGS:

2.1 **100 KVA,33/0.433 kV** Station Transformers.

3.0 STANDARDS:

3.1 The materials shall conform in all respects to the relevant Indian / International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed below:

Indian Standard	Title	International and Internationally recognized standards
IS - 2026	Specification for Power Transformers	IEC 76
IS - 12444	Specification for Copper wire rod	ASTM B - 49
IS - 335	Specification for Transformer Oil	BS 148, D - 1473, D - 1533-1934 IEC Pub 296
IS - 5	Specification for colors for ready mixed paints	
IS - 104	Ready mixed paint, brushing zinc chromate, priming	
IS - 2099	Specification for high voltage porcelain bushing	
IS - 649	Testing for steel sheets and strips and magnetic circuits	
IS - 4257	Dimensions for clamping arrangement for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76
IS – 2362	Determination of water content in oil for porcelain bushing of transformer	
IS – 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS – 6103	Testing of specific resistance of electrical insulating liquids	
IS – 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS – 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers	

3.2 Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidders shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

4.0 CLIMATIC CONDITIONS:

Please refer chapter- E3 of Technical Specification on climatic conditions

NOTE:-

The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth .

5.0 PRINCIPAL PARAMETERS:

5.1 The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 33 kV system in which the neutral is effectively earthed and they should be suitable for service with **fluctuations in supply voltage up to plus 12.5% to minus 12.5%**

5.2 The transformers shall conform to the following specific parameters:

Sl. No.	Item	33 kV Station Transformers
1	System voltage (max)	36 kV
2	Rated voltage HV	33 kV
3	Rated voltage LV	0.433KV
4	Frequency	50Hz (-5% to +3%)
5	No. of Phases	Three
6	Connection HV	Delta
7	Connection LV	Star (Neutral Brought out)
8	Vector group	Dyn – 11
9	Type of cooling	ONAN

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed transformers shall be as below (NEMA Standards):

kVA rating	Audible sound levels (decibels)
100 KVA	51

6.0 TECHNICAL REQUIREMENTS:

6.1 CORE MATERIAL – CRGO

- 6.1.1 The core shall be stack / wound type of high grade cold rolled grain oriented annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The values of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer
- 6.1.2 The bidder should offer the core for inspection and approval by the Owner during manufacturing stage.
- 6.1.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall **furnish necessary design data** in support of this situation.
- 6.1.4 **No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 433 volts, 50 Hz on the**

secondary. In crease of voltage of 433 volts by 12.5% shall not increase the no-load current by 6% (maximum) of full load current.

6.1.5 Flux density within the core should not exceed 1.5 web/sq meter at rated voltage & rated frequency.

7.0 WINDINGS:

7.1 Material:

7.1.1 HV and LV windings shall be wound from Supper Enamel covered / Double Paper covered copper conductor .

7.1.2 LV winding shall be such that neutral formation will be at top.

7.1.3 The winding construction of single HV coil wound over LV coil is preferable.

7.1.4 Inter layer insulation shall be Epoxy dotted Kraft Paper.

7.1.5 Proper bounding of inter layer insulation with the conductor shall be ensured. Test for bounding strength shall be conducted.

7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed technical .

7.1.7 Current density for HV and LV winding should not be more that 2.8 Ampere per sq mm at rated current & normal tap.

7.1.8 The core / coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

7.1.9 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

8.0 TAPS:

8.1 Tappings shall be provided, on the higher voltage winding for variation of HV voltage within range of (-) 5.0 % to (+) 7.5% in steps of 2.5%.

8.2 Tap changing shall be carried out by means of an externally operated self position switch and when the transformer is in de-energised condition. Switch position No. 1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Provision shall be made for locking the tapping switch handle in position. Suitable aluminium anodized plate shall be fixed for tap changing switch to know the position number of tap.

9.0 OIL:

9.1 The insulating oil shall comply with the requirements of IS335 or BS 148. **Use of recycled oil is not acceptable.** The specific resistance of the oil shall not be less than 2.5×10^{12} ohm-cm at 27°C when tested as per IS 6103.

9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

9.3 The oil shall be filled under vacuum.

9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

10.0 INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1	0.433	-	3
2	33	170	70

11.0 LOSSES:

11.1 The bidder shall guarantee individually the **no-load loss and load loss without any positive tolerance.** The bidder shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75°C).

11.2 The following maximum allowable losses at rated voltage and frequency and at 75°C shall be taken:

Voltage Rating	Rating (kVA)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)
33000/433 - 250 V	100	560	1820

Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above.

12.0 TOLERANCES:

12.1 **No positive tolerance** shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

13.0 PERCENTAGE IMPEDANCE:

13.1 The value of percentage impedance of transformer at 75 °C at normal tap shall be **5.0% (Minimum).** **No negative tolerances is allowed.**

14.0 TEMPERATURE RISE

The temperature rise over ambient shall not exceed the limits given below:

14.1 Top oil temperature rise measured by thermometer : 35 °C

14.2 Winding temperature rise measured by resistance method : 40 °C

NOTE : Bids not meeting the above limits of temperature rise will be treated as non-responsive

14.3 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

15.0 PENALTY FOR NON PERFORMANCE:

15.1 During testing at supplier's works **if it is found that the actual measured losses are more than the values quoted by the bidder, the Owner shall reject the transformer and he shall also have the right to reject the complete lot.**

15.2 Owner shall **reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.**

15.3 Owner shall reject any transformer during the test at supplier's works, **if the impedance values differ from the guaranteed values including tolerance.**

16.0 INSULATION MATERIAL:

i) Electrical grade insulation epoxy dotted Kraft Paper of standard make or any other superior material subject to approval of the Owner shall be used.

ii) All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations

17.0 TANK

17.1 The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

17.2 All joints of tank and fittings shall be oil tight and no bulging should occur during service.

17.3 Inside of tank shall be painted with varnish / hot oil resistant paint.

17.4 The top cover of the tank shall be slightly sloping to drain rain water.

17.5 The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

17.6 Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

17.0.A PLAIN TANK:

a) The transformer tank shall be of robust construction rectangular / octagonal / round / elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 6 mm for the bottom & top ;& not less than 4 mm for the sides . Tolerances as per IS 1852 shall be applicable.

b) In case of rectangular tanks the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm^2 for 30 minutes.

c) Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq.cm positive or negative.

d) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

e) Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

Horizontal length of flat plate in mm	Permanent deflection in mm
Upto 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	12.0
2501 to 3000	16.0
Above 3000	19.0

f) The tank shall further be capable of withstanding a pressure of 0.8 kg/sq.cm (g) and a vacuum of 0.7 kg/sq.cm (g) without any deformation.

g) The radiators can be tube or fin type or pressed steel type to achieve the desired cooling to limit specified temperature rise.

18.0 CONSERVATOR:

- 18.1 The conservator shall be provided on transformers for plain tank .
- 18.2 When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover.
- 18.3 The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 1Kg of silica gel conforming to IS 3410 .
- 18.4 The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variation. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- 18.5 The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- 18.6 The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to 0°C) should be above the sump level.

19.0 SURFACE PREPARATION AND PAINTING:

19.1 GENERAL

- 19.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 19.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is no possible, conventional spray be used with prior approval of Owner.

19.2 CLEANING AND SURFACE PREPARATION:

- 19.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

- 19.2.2 Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).
- 19.2.3 Chipping scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

19.3 PROTECTIVE COATING:

- 19.3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

19.4 PAINT MATERIAL:

- 19.4.1 Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site :Heat resistant paint (Hot oil proof) for inside surface.
- 19.4.2 For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel / polyurethane base paint. These paints can be either air drying or stoving.
- 19.4.3 Also paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

19.5 PAINTING PROCEDURE:

- 19.5.1 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.
- 19.5.2 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%

19.6 DAMAGED PAINTWORK:

- 19.6.1 Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.
- 19.6.2 Any damaged paint work shall be made good as follows:

- A. The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- B. A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.
- C. The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming .

19.7 DRY FILM THICKNESS:

19.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Over spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour

19.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.

19.7.3 Particular attention must be paid to full film thickness at the edges.

19.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl.No.	Paint type	Area to be painted	No. of coats	Total dry film thickness (min.) (microns)
1.	Thermo setting powder paint	Inside outside	01 01	30 60
2.	Liquid paint i.Epoxy (primer) i.P.U. Paint (Finish coat) i.Hot oil paint / Varnish	outside outside inside	01 02 01	30 25 each 35/10

19.8 TESTS FOR PAINTED SURFACE:

19.8.1 The painted surface shall be tested for paint thickness.

19.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

20.0 BUSHINGS:

- 20.1 The bushings shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for both HT and LT bushings. The tests as per latest IS 2099 and IS 7421 shall be conducted on the transformer bushings.
- 20.2 For 33 kV, 33 kV class bushings; for 0.433 kV, 1.1 kV class bushings shall be used.
- 20.3 Bushing can be of porcelain /epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.
- 20.4 Bushing of plain shades as per IS 3347 shall be mounted on the side of the tank and not on top cover.
- 20.5 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.
- 20.6 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	350 mm	320 mm
LV	75 mm	40 mm

The clearances in case of cable box shall be as below:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	351 mm	222 mm
LV	45 mm	20 mm

- 20.7 Arcing horns shall be provided on HV bushings.
- 20.8 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX.
- 20.9 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- 20.10 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

21.0 TERMINAL CONNECTORS:

The HV bushing stems shall be provided with suitable terminal connectors suitable as per IS 5082 so as to connect the jumper without disturbing the bushing stem.

Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561. The terminal arrangement for 433volts side shall be such as to suit 3 ½ X300 mm² armoured PVC cable .

22.0 TERMINAL MARKINGS:

High voltage phase windings shall be marked both in the terminal boards inside the tank and one the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral is to be brought out and connected to local grounding terminal by an earthing strip.

23.0 FITTINGS:

The following standard fittings shall be provided:

- i) Rating and terminal marking plates, non-detachable.
- b. Earthing terminals with lugs – 2 Nos.
- c. Lifting lugs for main tank and top cover.
- d. Terminal connectors on the HV / LV bushings (For bare terminations only)
- e. Thermometer pocket with cap – 1 No.
- f. Air release device
- g. HV bushings – 3 Nos.,
- h. LV bushings – 4 Nos.
- i. Pulling lugs.
- j. Stiffener
- k. Radiators – No. and length may be mentioned (as per heat dissipation calculations) / corrugations.
- l. Arcing horns on HT side 3 nos.
- m. Prismatic oil level gauge.
- n. Drain cum sampling valve.
- o. Top filter valve.
- p. Oil filling hole having p. 1- ¼” thread with plug and drain plug on the conservator.
- q. Silica gel breather.
- r. Base channel 100 mm x 50 mm, 460 mm long with holes to make them suitable for fixing on a platform or plinth.

- s. 4 Nos. rollers
- t. Pressure relief device or explosion vent.

24.0 FASTENERS:

All bolts, studs screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

All nuts and pins shall be adequately locked.

Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing, except high tensile steel bolts and spring washers which shall be electro-galvanized / plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are accessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back of the securing screws.

25.0 OVERLOAD CAPACITY:

The transformers shall be suitable for loading as per IS 6600.

26.0 TESTS:

26.1 The type tests as indicated at clause-28 below should have been conducted on a transformer of **same design** during the **last five years on the date of**

opening of techno-commercial bids. The bidder shall furnish type test reports during detailed Engineering & drawing approval.

26.2 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted reports during detailed Engineering & drawing approval.

26.3 The procedure for testing shall be in accordance with IS 1180/2026 as the case may be except for temperature rise test.

26.4 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

26.0A. ROUTINE TESTS:

26.1A Ratio, polarity, phase sequence , vector group & magnetic balance test.

26.2A No Load current and losses at service voltage and normal frequency.

26.3A Load losses at rated current and normal frequency.

26.4A Impedance voltage test.

26.4A Resistance of windings at each tap, cold (at or near the test bed temperature).

26.5A Insulation resistance at 60second,600 second & Polarisation Index (P.I i.e ratio of Insulation Resistance taken at 600seconds & at 60 seconds shall not be less than 1.5)

26.6A Induced over voltage withstand test.

26.7A Separate source voltage withstand test.

26.8A Neutral current measurement – The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.

26.9A Oil samples (one sample per lot) to comply with IS 1866.

26.10A Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 112.5% rated voltage.

26.11A Pressure & vacuum test for checking the deflection & oil leakage test.

26.0 B. TYPE TESTS :

Following type test reports are also to be furnished during detailed Engineering & drawing approval. If not furnished than the same will not be accepted for further processing & liable for rejection.

26.1B Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.

26.2B Impulse voltage test: with chopped wave of IS 2026 part – III .

26.3B Short circuit withstand test: Thermal and dynamic ability.

26.4B Air Pressure Test: As per IS – 1180.

26.5B Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.

26.6B Noise-level measurement.

26.7B Measurement of zero-phase sequence impedance.

26.8B Measurement of Harmonics of no-load current.

26.9B Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto 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	12.0
2501 to 3000	16.0
Above 3000	19.0

26.10B Transformer tank together with its radiator and other fittings shall be subjected to pressure corresponding to twice the normal pressure or 0.35 kg / sq.cm whichever is lower, measured at the base of the tank and maintained for an hour. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.

27.0 Pressure relief device test:

The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.

28.0 Short Circuit Test and Impulse Voltage Withstand Tests:

The Owner intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be

required to carry out the short circuit test and impulse voltage withstand test **at their own cost in the presence of the representative of the Owner.**

28.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.

28.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.

28.3 It may also be noted that the Owner reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at Owner cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the Owner either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to Owner's stores. The findings and conclusions of these tests shall be binding on the supplier.

28.4 Type test certificates for the tests carried out on prototype of same specifications shall be **submitted along with the bid**. The Owner may select the transformer for type tests randomly.

29.0 ACCEPTANCE TEST:

29.1 **All transformers** shall be subjected to the stage inspection, routine & acceptance test as indicated above in presence of Owner's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 and IS:2026.

29.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.

29.3 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.

29.4 **Temperature rise test on one unit of the total ordered quantity.**- This test shall be carried out as per IS.

29.5 The pressure & vacuum test on the tank on one unit/lot randomly selected to be carried out as per SI No. 28.8 & 28.9.

29.0A TESTS AT SITE:

The Owner reserves the right to conduct all tests on transformer after arrival at site and the manufacturer shall guarantee test certificate figures under actual service conditions.

Precommissioning test: If any defect observed in the parts or during precommissioning test, the corresponding detailed tests will be done.

30.0 INSPECTION:

30.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured / supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the Owner. The bidder shall furnish following documents along with their offer in respect of the raw materials:

- (a) Invoice of supplier.
- (b) Mill's certificate.
- (c) Packing list.
- (d) Bill of landing.
- (e) Bill of entry certificate by custom.

31.0 INSPECTION AND TESTING OF TRANSFORMER OIL:

31.1 To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of Owner's representative.

31.2 To ensure about the quality of transformers, the inspection shall be carried out by the Owner's representative at following two stages:-

31.2.1 On line anytime during receipt of raw material and manufacture / assembly whenever the Owner desires.

31.2.2 At finished stage i.e. transformers are fully assembled and are ready for dispatch.

31.2.3 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and Owner at the time of purchase. The manufacturer shall offer the Inspector representing the Owner all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. this will include

Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.

31.2.4 The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.

31.2.5 Owner shall have every right to appoint a third party inspection to carry out the inspection process.

31.2.6 The Owner has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Owner has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation Owner **have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.**

32.0 DOCUMENTATION:

33.1 The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.

33.2 Dimensional tolerances.

33.3 Weight of individual components and total weight.

33.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.

33.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.

33.6 Typical general arrangement drawing showing both primary and secondary sides and end-elevation and plan of the transformer.

33.0 PACKING AND FORWARDING:

34.1 The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.

34.2 The marking on each package shall be as per the relevant IS.

34.0 DEVIATION:

35.1 The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the

absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specification and no post-bid negotiations shall take place in this regard.

35.2 The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and representations in this regard shall not be entertained.

35.3 If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.

35.4 All the tables shall be prepared by vendor and are to be enclosed with the bid.

ANNEXURE-I

PROFOREMA FOR PRE-DELIVERY INSPECTION OF STATION TRANSFORMERS

1.	Name of the firm.	
2.	Details of offer made	
	(i) Order No. and Date.	
	(ii) Rating.	
	(iii) Quantity.	
	(iv) Sl. No. of transformer.	
3.	Date of stage inspection clearance.	
4.	Reference of stage inspection clearance.	
5.	Quantity offered and inspected against the order prior to this lot.	

ANNEXURE-II

ROUTINE/ ACCEPTANCE TESTS TO BE CARRIED OUT(Clause-27,29 above & ISS)

Sl. No.	PARTICULARS	OBSERVATIONS.
1.	(a) Ratio Test	AB/an
		BC/bn
		CA/Cn
	(b) Polarity Test, Vector Group, Phase Sequence	
	c) Magnetic Balance	
2.	No load loss measurement	
		W1
		W2
		W3
	TOTAL	
	Multiplying Factor	
	CT	

	Watt meter	
	Total x MF	
	NET LOSS	
3.	Load loss measurement	
		W1
		W2
		W3
	Total	
	Multiplying Factors:	
	CT	
	Watt meter	
	PT	
	Total x MF	
	Loss at ambient temperature (watt)	
	Loss at 75° C (with calculation sheet)(watt)	
4.	Winding Resistance:	
	H.V. (In Ohms)	
	(a) At ambient temperature of ° C	A-B
		B-C
		C-A
	(b) Resistance at 75° C	A-B
		B-C
		C-A

SI. No.	PARTICULARS	OBSERVATIONS.
	L.V. (In Ohms)	
	(a) At ambient temperature of ° C	a-b
		b-c
		c-a
	(b) Per Phase Resistance at 75° C	a-n
		b-n
		c-n
5.	Insulation Resistance (M ohm)	HV-LV
	60sec,600sec , Polarisation Index(P.I)	HV-E
		LV-E
6.	Separate Source voltage withstand test voltage	
	HV	70 kV for 60 secs.
	LV	3 kV for 60 secs
7.	Induce over-voltage withstand test at double voltage and double frequency.	100 Hz, 866 volts For 60 seconds.
8.	No load current at	
	90% volts	
	100% Volts	
	110% volts	
9.	Unbalance current	
10.	Vector group test	Diagram and readings be shown in separate sheets.
11.	Percentage Impedance at 75° C(Please furnish	

	calculation sheet)	
12.	Transformer oil test (Break down voltage)	
13.	Oil leakage test	
14.	Heat run test	To be carried out once against the order.
15.	Bushing clearance (mm)	HV LV
	(a) Phase to Phase	
	(b) Phase to Earth	
16.	Comments on compliance by the firm on the modifications done as per stage inspection clearance letter issued.	
17.	Whether fittings of the order have been verified	
18.	Whether aluminium die cast silicagel breather with tin container is fitted on the transformers offered.	
19.	Whether engraving of Sl.No. and Name of firm on core clamping channel, side wall and top cover of tank has been verified.	
20.	Whether MS Plate of size 125 x125mm welded on with side of stiffner.	
21.	Whether engraving of name of firm, Sl.No. and Rating of transformer, Order No. and date and Date of Despatch on MS Plate.	
22.	Copy of calibration certificate of metering equipments be enclosed.	

Note:- If the Owner's Inspecting officer wants to note & incorporate any other readings pertaining to the above tests then the same shall have to be incorporated in the test report by the supplier. Also if the inspecting officer decides to carry out any other low voltage tests to know the soundness of the transformer then the same shall have to be carried out by the supplier.

Note : Please ensure that complete details have been filled in the proforma and no column has been left blank. The guaranteed technical particulars shall be filled up in GTP of Chapter E-24

CHAPTER – E5 - 3

33 KV VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE)

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OF
36 KV VACCUM CIRCUIT BREAKERS
(OUT DOOR TYPE)

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TECHNICAL SPECIFICATION FOR 36 KV VACCUM CIRCUIT BREAKERS (OUTDOOR TYPE)

1.0. SCOPE:

36kV, 1430MVA Circuit Breakers are intended to be purchased for installation at different Sub-stations. Some of the Sub-stations for which equipment are tendered are situated in coastal areas where saline climate prevails. The base structure of the circuit breakers must be galvanized.

1.1. POWER SUPPLY TO AUXILIARIES :

A.C. supply to auxiliaries will be 3 phase, 3 wire, 430 volt or single phase 250 volts at 50 C/s. The voltage variation will be within 10% and the frequency variation -5% to +3%

1.2. 33 K.V. CIRCUIT BREAKERS TYPE AND RATING :

The circuit breakers shall be vacuum type suitable for outdoor operation under the climatic conditions specified without any protection from sun and rain.

The circuit breaker shall have the following ratings :

Sl. No.	Description in details	Required value
1.	Number of poles	: 3 (One unit with three phase making and breaking).
2.	Frequency.	: 50 C/s.
3.	Nominal system voltage	: 33 KV rms.
4.	Highest system voltage	: 36.0 KV rms.
5.	Basic insulation level	: 170 KVP
6.	Power frequency test Voltage (wet).	: 70 KV (rms.)
7.	Nominal Current.	: 1250 Amps rms.
7a.	First pole to clear factor	: 1.5
8.	Breaking capacity.	
	(a) Symmetrical	: 25 KA/1430 MVA.
	(b) A symmetrical	: 33 KA Peak
9.	Making capacity	: 62.5 KA Peak.
10.	Continuous current rating	: 1250 Amps (RMS)
11.	Operating Duty	: 0-0.3 Sec-CO-3 Min-CO.
12.	(a) Break time	: 3 Cycles
	(b) Make time	: 5 Cycles
	(c) Minimum reclosing time	: 15 Cycle.
	(d) Minimum dead time for reclosing	: 15 Cycle
13.	Dry one minute power frequency withstand test voltage	
	a) Between line terminal	: 75 KV rms.
	b) Between line and body	: 75 KV rms.
14.	Impulse withstand test voltage;	
	a) Between terminal with C.B. open.	: 170 KV (Peak)
	b) Between body & terminal	: 170 KV (Peak)
15.	Insulator or bushing	
	a) Dry one minute power	: 70 KV

Frequency voltage,		
b)Wet one minute power	:	75 KV
Frequency withstand Voltage.		
c) Creepage distance	:	900 mm (Minimum)
16. Short time current	:	Not less than 25 KA for
rating for 3 seconds	:	3 seconds.
17.Control circuit voltage:		48V D.C/24V/220V (matching with source substation)

2.0 STANDARDS :

The circuit breakers shall comply with the requirements of latest issue of IEC-62271-100, IEC-60694/IS12729:2004, IS-13118:1991.

3.0 CLIMATIC CONDITIONS :

Please refer chapter E3 of Technical Specification on climatic conditions

Some of the breakers to be purchased against this specification are intended to be installed on the sea coast having extremely saline climate. Necessary anti corrosive provisions need be incorporated.

4.0 TECHNICAL DETAILS

4.1 GENERAL :

- a) The circuit breakers shall be of Vacuum type. The breakers shall be furnished as a complete unit with all accessories and equipment in place and all internal wiring installed and terminated in the mechanism.
- b) The circuit breakers shall provide rapid and smooth interruption of current under all conditions, completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents of leading or lagging reactive current. The details of any device incorporated to limit or control the rate of rise of restricting voltages across the circuit breaker contacts shall be stated. **The over voltages caused by the circuit breaker switching on inductive or capacitive load shall not exceed, 2.5 times the normal phase to neutral voltage.** The total break time for the circuit breakers throughout the range of their operating duty shall be stated in the tender and guaranteed.

5.0 CONSTRUCTIONAL FEATURES :

Each circuit breaker shall comprise 3 identical poles complete with a gang operated mechanism for specified duty. All these poles of the C.B. shall be linked together Electrically, Mechanically for specified duty.

The breaker shall be capable of interruptions of low reactive current (lagging/leading) without undue over voltage and restrike.

a) CONTROL CUBICLE :

A common control cubicle shall be furnished to house electrical controls, monitoring devices and all other accessories. The cubicle shall be of gasketed weather proof construction, fabricated from sheet Aluminum alloy sheet having minimum 3 mm thick. **CRCA sheet having 3 mm for load bearing & 2 mm for others is also acceptable. The operating mechanism shall be strong,rigid and not subject to rebound.**

The cubicle shall have front access door with lock and keys and removable gland plate at the bottom for owner's cable entry. Thermostat controlled space heater, internal illumination lamp, 5A 3Pin socket with individual on off switches shall be provided in the cubicle.

6.0 MOUNTING :

The circuit breakers shall be suitable for mounting on steel galvanized structures. The prices of necessary frames for mounting the circuit breaker shall be included with the offer. A ladder should be provided in the circuit breaker structure for easy access to the operating mechanism house. The ladder shall be of M.S with hot dip galvanised.

The circuit breakers shall consist of three identical single phase units with a common operating mechanism. All joints shall be welded so as to have adequate mechanical strength. The breaker porcelain shall be capable of withstanding all pressure resulting from any specified performance of the breaker.

The circuit breaker shall be supplied complete with the necessary lifting tools, foundation bolts and other accessories.

7.0 TEMPERATURE RISE :

The maximum temperature attained by any part of the equipment when in-service at site under continuous full load conditions and exposed to direct rays of sun shall not exceed the permissible limits fixed by approved specifications. When the standards specifies the limits of temperature rise these shall not exceed when corrected for the difference between ambient temperature at site and the ambient temperature specified in the specification.

8.0 INSULATION OF THE CIRCUIT BREAKERS :

The insulation to ground, the insulation between open contacts, the insulation between phases of the completely assembled circuit breakers, should be capable of withstanding satisfactorily die-electric test voltages corresponding to basic insulation level specified wheresoever in clause.

8.1 The clearance in open air shall be as follows, unless the apparatus is impulse tested after complete assembly.

- i) Minimum clearance between phase : 505 mm
- ii) Phase to Earth : 305 mm
- iii) Minimum clearance between live : 1400 mm
Parts and grounded objects.
- iv) Minimum ground clearance from live: 3700 mm
part.

9.0 BUSHING AND INSULATIONS :

The basic insulation level of the insulating porcelains shall be as specified and shall be suitable for installation in contaminated atmospheres. The porcelains used shall be homogenous and free from cavities and other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified

above. The puncture strength of the bushings shall be greater than the flashover value. The bushings shall be entirely free from radio disturbance when operating at a voltage 10% above rated voltage and also be free from external corona.

Adequate means shall be provided to accommodate conductor expansion and there should not be any undue stressing of any part due to temperature change.

10.0 OPERATION MECHANISM :

- 10.1 The operating mechanism shall be spring operated type. In case of spring operating mechanism it shall be of motor operated having provision of hand operated spring charging type or by local/remote electric control under normal operation. The mechanism shall be trip from electrically and mechanically. All working parts in the mechanisms shall be corrosion resistant material and all bearings which require greasing shall be equipped with pressure grease fittings. The mechanism shall be strong, positive, quick in action and shall be removable without disturbing the other parts of the circuit breakers. The mechanisms of breaker shall be such that the failure of any spring will not prevent tripping.
- 10.2 The operating mechanism along with its accessories shall be mounted in a weather proof cabinet with hinged doors located near the breakers. A local control switch and the breaker position indicator shall be provided in the cabinet. The circuit breakers shall also be provided with means for manual operation for maintenance purposes.
- 10.3 The control circuits shall be designed to operate on **48V D.C.** It shall be possible to adopt to work on other voltages by simply changing the operating coils. The closing and operating coils shall be designed to operate satisfactorily at any control voltage from 70% to 115% of the normal rated voltage. A heater shall be provided in the cabinet to prevent moisture condensation.
- 10.4 Necessary cable glands for the cables of the operating mechanism shall be provided.
- 10.5 **All the terminal blocks to be used in the operating mechanism should be of stud type of Poly-amide material of make Elmex / Connectwell.**
- 10.6 **The Motor to be used for spring charging shall be of Universal type and suitable for AC 230 V.**

11.0 TERMINAL CONNECTORS :

Terminal connectors suitable for the AAAC conductor size 148 Sq mm shall be supplied.

12.0 AUXILIARY SWITCHES :

Spare 10 Nos N/O (normally open) & 10 Nos N/C (normally closed) of auxiliary switches (contacts) shall be provided on each circuit breaker for use in the remote indication and control scheme of the circuit breaker and for providing safety interlocking etc. Special contact for use with trip coil and

single short reclosing operation which permits relative adjustment with respect to the travel of the moving contact of the circuit breaker shall also be provided. There shall be provision to add more auxiliary switches at the later date if required.

13.0 COMPLETENESS OF EQUIPMENT :

Any fittings, accessories or apparatus which may not have been specifically mentioned in those specification but which are usual or necessary in the equipment of similar plant shall be deemed to be included in the contract and shall be supplied by the contractor without extra charges. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not. The detail bill of materials list to be furnished along with the tender.

14.0 TEST :

14.1 Type test : -

All the equipment offered shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered, has already been type tested in an Govt. Approved test Laboratory. These tests **must not have been conducted earlier than five years from the date of opening of bids**. All the test reports should be submitted during detailed Engg & approval of drawings for verification by the Owner.

Following type test reports are to be furnished:

Type Tests:--(As per IEC-62271-100)

- 1) Dielectric Test (LI Voltage, PF Voltage Withstand(Dry&Wet) & etc)
- 2) RIV Test
- 3) Measurement of resistance of the main circuit
- 4) Temperature rise Test
- 5) Basic short circuit duty test ,Short Time withstand current & Peak withstand current Test
- 6) Mechanical Operation Test, Mechanical endurance test
- 7) Out of phase / Short Circuit making & Breaking Test
- 8) Capacitive Current, Switching Test ,
 - a) cable charging current Test
 - b) Single capacitor Bank current switching test
- 9) Test to verify degree of protection

14.2 Routine Tests:-

- 1) Dielectric Tests on the main Circuit ,auxiliary & control circuits
- 2) Measurement of resistance of the main circuit.
- 3) Design & Visual Checks(Dimensions,clearances&etc)
- 4) Mechanical operation Test
- 5) Operating time of the device, motor Characteristics, measurement of coil current & resistance, SF6 gas pressure monitoring ,electrical scheme,control Circuit, antipumping, vacuum interrupter (type,make&etc), dimensions, name plate details, contact travel & timing checks .

14.3 Acceptance and Routine Tests.

All acceptance and routine tests as stipulated in the relevant standards & above shall be carried out by the supplier in presence of owner's representative.

Immediately after finalization of the programme of **acceptance /routine testing**, the contractor shall give fifteen days advance intimation to the Owner-to enable him to depute his representative for witnessing the tests.

15.0 INSPECTION :

The inspection may be carried out by the Owner at any stage of manufacture. The manufacturer shall grant free access to the Owner's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipments under this specification by the Owner, shall not relieve the EPC contractor/supplier in his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the Owner informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The Owner reserves the right to insist for witnessing the acceptance/routine testing of the bought out items

16.0 DOCUMENTATION :

All drawings of the VCB shall be furnished to the owner along with the GTP, Type test reports for verification. All dimensions and data shall be in S.I. Units.

List of drawings and documents.

The Contractor shall furnish following drawings .

- (a) General outline and assembly drawings of the equipment.
- (b) Graphs showing the performance of equipments
- (c) Sectional views showing :-
 - i) General Constructional features.
 - ii) The materials/gaskets/sealing used.
 - iii) method of connections.
 - iv) Porcelain used and its dimensions along with the mechanical and electrical characteristics.
- (d) Arrangement of terminal's and details of connection studs provided.
- e) Name Plate.
- f) Schematic drawing :-
- g) Type test reports in case the equipment has already been type tested.
- h) Test reports, literature, pamphlets of the bought out items, and raw material.

The Contractor shall submit 2 (two sets) of all above said drawings to PMC for approval. The PMC shall communicate his comments/ approval on the drawings and if required, the Contractor through manufacturer shall modify the drawings and resubmit the same for PMC approval.

Adequate copies of acceptance and routine test certificates, 4 sets each, duly approved by the Owner /authorised person, shall accompany the dispatched consignment.

The manufacturing of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the the written approval of the Owner.

4 sets printed and bound volumes of operation, maintenance and erection manuals in English language for each type and rating of equipment supplied shall be submitted by the supplier for distribution, prior to the dispatch of the equipment. The manual shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manual shall also contain a set of all the approved drawings, type test reports etc.

CHAPTER - E5 - 4

CURRENT TRANSFORMERS (OUT DOOR)

33KV CT RATIO- 400-200 /1-1-1A

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OF
CURRENT TRANSFORMERS**

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TECHNICAL SPECIFICATION FOR 33KV CURRENT TRANSFORMERS WITH METERING CORES OF ACCURACY CLASS 0.2

1.0 SCOPE :

1.1. The specification covers the design, manufacture, assembly, inspection and testing at the manufacture's work, packing and delivery F.O.R. (destination) of the outdoor mounted dead tank/live tank type, single phase, single unit type current Transformers for protection and metering services in 33KV solidly grounded system.

1.2. The current transformers shall be of the outdoor type, single phase, 50 C/S, oil immersed, self cooled, hermetically sealed and suitable for operating in the tropical conditions with maximum ambient temperature up to 50°C. The C.Ts should be suitable for use in the areas subject to heavy lightning storms and highly polluted conditions.

1.3 The current transformer shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and Owner shall have the power to reject any work or material which in his judgment is not in full accordance therewith.

1.4 Bidders are required to quote for CTs as per the following data / information etc.

CT Primary Current: 400-200-100 A

CT Secondary Current: 1-1-1 A

Core 1: CI-0.2 S/ 15 VA,

Core 2: PS class (Knee point voltage 400 V, Max Excitation current 25 mA, Rct =5 ohm.

Core3: PS class (Knee point voltage 400 V, Max Excitation current 25 mA, Rct =5 ohm.

Short time rating – 25 kA for 3 sec

2.0 STANDARDS

2.1 Except to the extent modified in the specification, the C.TS shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title
1	IEC-44	Instrument transformer-measurement of PDS
2.	IEC-60	High Voltage Testing Technique.
3.	IEC-171	Insulation co-ordination
4.	IEC-185	Current Transformers.
5.	IEC-270	Partial Discharge Measurement
6.	IEC-8263	Method for RIV Test on High Voltage Insulators.

7.	IS-335	Insulating oil for Transformers
8.	IS:2071	Method of High Voltage Testing
9.	IS:2099	High Voltage porcelain Bushings
10.	IS:2147	Degree of Protection Provided by Enclosures for Low Voltage Switchgear and Control.
11.	IS:2165	Insulation Co-ordination for equipment of 100KV and above
12.	IS:2705 [Part-I to IV)	Current Transformers
13.	IS:3347	Dimensions of Porcelain Transformer Bushing
14.	IS:5621	Specification for Large Hollow Porcelain for use in Electrical installation.
15.	IS:4201	Application guide for CTS
16.		Indian Electricity Rules, 1956
17.	<i>IS:13072 –of1991</i>	<i>SF6 Gas (for 220kv SF6 gas filled CTs only)</i>
18.	<i>IEC:60376</i>	<i>SF6 Gas(for 220kv SF6 gas filled CTs only)</i>

3.0 CLIMATIC & SERVICE CONDITIONS :

Please refer chapter E3 of Technical Specification on climatic conditions.

4.0 GENERAL TECHNICAL REQUIREMENTS :

4.1 The C.T. shall be of dead/live tank design and shall be so constructed that it can be easily transported to site within the allowable limitation and in horizontal position if the transport limitations so demand. For compensation of variation in the oil volume due to ambient variation, nitrogen cushion / metal bellows shall be used. Rubber diaphragms shall not be permitted for this purpose.

4.2 The C.T. secondary terminals shall be brought out in a weather proof terminal box.

The terminal box shall be provided with removable gland plate and gland (s) suitable for 1100 volts grade PVC insulated, PVC sheathed, multicore 4 Sq. mm stranded copper conductor cable. The terminal blocks shall be stud-type and provided with ferrules indelibly marked or numbered. The terminals shall be rated for not less than 10 Amps. The terminal box shall be dust and vermin proof. Suitable arrangements shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with the use of normal tools.

- 4.3 Polarity shall be indelibly marked on each primary and secondary terminal. Facility shall be provided for short-circuiting and grounding of the C.T. secondary terminals inside the terminal box.
- 4.4 The C.T. shall be provided with non-corrosive, legible name plate with the information, specified in the relevant standards, duly engraved/punched on it.
- 4.5 The current Transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and / or sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the C.T. The method adopted for hermetic sealing shall be described in the offer.
- 4.6 The castings of base, collar etc. shall be die cast and tested before assembly to detect cracks and voids, if any.
- 4.7 The instrument security factor of metering core shall be low enough and not greater than '5'. This shall be demonstrated on all the ratios of the metering core in accordance with procedure, specified in IEC-185 OR IS: 2705. In case the instrument security factor of 5 or less is not possible to be achieved on higher ratios, Current transformers' guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- 4.8 Current Transformers shall be designed so as to achieve the minimum risk of explosion in service. The Bidder shall bring out in his offer, the measures taken to achieve this.

5.0 PRIMARY WINDING

5.1 Primary winding may be either ring type or hair pin type or the type, which has been type tested. For 33KV class C.Ts, the rated extended primary current shall be 120% on all cores of the C.Ts, specified in tables.

5.1.1 The primary windings of current transformers shall be constructed of high purity, annealed, high conductivity electrolytic copper/Aluminium meeting to the requirements of IEC 28/IS: 2705.

5.1 SECONDARY WINDINGS:

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. Type of insulation, used shall be described in the offer. The secondary taps shall be adequately reinforced to withstand handling without damage.

The rating of the Current Transformer's secondary winding shall be 1 (One) Amp. The secondary terminals shall be brought out in a compartment for easy access.

5.3 PRIMARY TERMINALS

The primary terminals shall be heavily tinned electrolytic copper or Aluminium alloy of 99.9% conductivity. The minimum thickness of tinning shall be 1.5 microns.

5.4 SECONDARY TERMINALS

5.4.1 Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the stud shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between the centers of the adjacent studs shall be at least 1.5 times the outside circum-dia of the nuts.

5.4.2 The current transformer shall be provided with suitable test tap for measurement of capacitance, tan delta as well as partial discharges. Provision shall be made on a screw cap for solid and secured earthing of the test tap connection, when not in use. A suitable caution plate shall be provided duly fixed on the cover of the secondary terminal box indicating the purpose of the test tap and the necessity of its solid earthing as per prescribed method before energising the Current Transformer.

5.4.3 The secondary terminals shall be provided with shorting arrangements.

5.5 CORE

Core laminations shall be of cold rolled grain oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure high accuracy at both normal and over-current conditions. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios, with specified Current Transformer parameters. The core material, thickness of lamination, the relevant graphs showing the characteristics of the core material shall be submitted along with the offer.

5.6 TANK

5.6.1 Both expansion chambers and the tanks of the Current Transformers shall be made up of high quality steel, which should be able to withstand full vacuums and pressure occurring during transit and thermal and mechanical stresses resulting

from maximum short circuit current during operation. The tanks along with all ferrous parts shall be galvanised as per relevant standard.

- 5.6.2 The metal tanks shall have bare minimum number of welded joints so as to minimise possible locations of oil leakage. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from Owner for any horizontal welding used in the bottom tank.

5.7 SECONDARY TERMINAL BOX :

- 5.7.1 Secondary Terminal Boxes shall be weather proof with a rating not less than IP 55
- 5.7.2 All secondary terminals shall be brought out in a compartment on one side of each current transformer for easy access.
- 5.7.3 The exterior of this terminal box shall be of aluminium alloy sheet of minimum 3 mm thickness.
- 5.7.4 A terminal board which shall have arrangement for series / parallel connection and arrangement for shorting of secondary terminals shall be provided. For 33KV C.Ts, at least one of the ratios should be achieved through secondary tapping(s). I.e. primary re-connection is allowed for two ratios where as third ratio is to be achieved by provision of secondary tapping or alternatively all the stipulated ratios may be achieved through secondary tappings. Series parallel connection or by secondary tapping.
- 5.7.5 The terminal box shall be provided with a removable cable gland plate at bottom for mounting cable glands for 1.1KV PVC sheathed 3 nos. of 4x 4 Sq. mm stranded copper conductor cables.
- 5.7.6 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing / locking arrangement and shall be suitable to prevent penetration of moisture and rain water.
- 5.7.7 All terminals shall be clearly marked with identification number to facilitate connection to external wiring.
- 5.7.8 The secondary box of the CT's also of high quality steel materials with galvanizing as per standard (IS).

PORCELAIN HOUSING

- 5.7.8.1 The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength, Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rain water or condensed water particles (fog.) The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.
- 5.7.8.2 The bushings of the Current Transformers shall conform to the latest edition of IS: 2099. The hollow porcelain insulator shall conform to the latest edition of IS: 5621.
- 5.7.8.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength.
- 5.7.8.4 The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.
- 5.7.8.5 Cast metal end caps for the bushings shall be of high strength, hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.
- 5.7.8.6 The insulation of bushings shall be coordinated with that of the current transformer such that the flashover, if any, will occur only external to the Current Transformer.
- 5.7.8.7 Oil level gauge and convenient means of filling, sampling and draining of oil should be provided.
- 5.7.9 End shields should be provided for distribution of stresses.
- 5.7.10 Corona shields for bushings, if required should be provided.

5.8 INSULATING MEDIUM (OIL TYPE)

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall be stated. The oil shall comply in all respects with the provisions of latest edition of IS: 335. The current Transformers shall be supplied, filled with purified oil completely.

5.8.1 PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:

The supplier shall ensure that the sealing of the Current Transformer is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings.

- (a) locations of emergence of primary and secondary terminals.
- (b) Interface between porcelain housing and metal tank/s
- (c) Cover of the secondary terminal box.

5.8.2 Nuts and bolts or screws, used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.

5.8.3 For gasketed joints, wherever used, nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

5.9 FITTINGS AND ACCESSORIES :

Fittings and accessories, listed below shall be supplied with each Current Transformer. Any fitting, required essential other than those listed below shall also be supplied along with each Current Transformer without any extra cost to the Owner:

- (a) Oil level gauge.
- (b) Oil filling hole and cap.
- (c) Pressure relieving device.
- (d) Phase terminal connectors.
- (e) Lifting lugs for core and windings, bushings and complete Current Transformers.
- (f) Tank earthing pads/terminals with necessary nuts, bolts and washers for connecting to Owner's earth strip.
- (g) Name / Rating plate.

5.9.1 (A) OIL LEVEL GAUGE :

An oil level gauge shall be provided to indicate the oil level in the Current Transformer. This gauge shall be mounted in such a way that the oil level can be seen from ground level. If metal bellow is used, a ground glass window shall be provided to monitor the position of the metal bellow. The metal below shall be tested in accordance with relevant standards. The details shall be to the approval of the Owner.

5.9.2 PRESSURE RELIEVING DEVICE :

Each Current Transformer shall be provided with a pressure relieving device so as to protect bushing of the Current Transformer even under unfavorable conditions. In

case of non provision of the PRD, the same should be brought out clearly in the offer with detailed explanation and proof.

5.9.3 (A) OIL DRAIN COCK :

An oil drain cock along with a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

5.9.4 EARTHING :

Metal tank of each Current Transformer shall be provided with two separate earthing terminals for bolted connection to 50mm X 6 mm flat, to be provided by the Owner for connection to station earth-mat.

5.9.5 LIFTING ARRANGMENT :

The Current Transformer shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation / transport. Necessary string guides shall be offered which shall be of removable type.

5.9.6 NAME PLATE & MARKING :

5.9.6.1 The Current Transformer shall be provided with non-corrosive, legible name plate with the information specified in relevant standards, duly engraved/punched on it.

5.9.6.2 A schematic drawing indicating the connections shall be provided in the interior of the Terminal box.

5.9.7 TERMINAL CONNECTORS :

All the Current Transformers shall be provided with bimetallic solder less clamp type, rigid type terminal connectors, suitable for

(i) **33KV C.T. – AAAC 150 Sq mm conductor.**

Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors / station bus bars.

5.9.7.1 Terminal connectors shall be manufactured and tested as per IS: 5561.

5.9.7.2 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

5.9.7.3 No part of a clamp shall be less than 10mm thick.

5.9.7.4 All ferrous parts shall be hot-dip galvanised conforming to relevant standard.

- 5.9.7.5 For bimetallic connectors, copper alloy linear of minimum thickness of 2 mm shall be cast integral with aluminium body.
- 5.9.7.6 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 5.9.7.7 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS: 5561.

6.0 TEST:

6.1 TYPE TESTS & SPECIAL TESTS:-

The current transformers, offered should have been subjected to the following type tests and Special Tests in Government approved test laboratory. The bidder shall furnish four sets of type test and Special Tests reports along with the offer for 0.2 accuracy class CTs. These tests should not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and the design/type offered against this specification, the Owner reserves the right to demand repetition of some or all type & special tests without any extra cost to OPTCL in the presence of OPTCL's representative(s) at the cost of the supplier.

- (a) Lightning Impulse Voltage Test.
- (b) High Voltage power frequency wet withstands voltage Test.
- (c) Short time current test.
- (d) Temperature rise test.
- (e) Determination of errors or other characteristics according to the requirements of the appropriate designation and accuracy class as per individual parts of IS: 2705.
- (f) Instrument Security Factor Test.
- (g) IP-55 Test on Secondary Terminal Box.

N.B:

- Lightning Impulse Test, switching Impulse Voltage test and High Voltage power frequency wet withstand voltage Tests should have been carried out on the same current transformer.
- After the current transformers have been subjected to lightning Impulse Test, and High Voltage power frequency wet withstand voltage tests, these must have been subjected to all the routine tests as per IS:2705 (Part-I to IV).

6.2 ROUTINE TESTS :

The following routine tests shall be conducted on each Current Transformer in the presence of OPTCL's representative(s) for which no charges will be payable by OPTCL. No sampling will be allowed.

- (i) Appearance and Dimensional Check.
- (ii) Verification of Terminal Marking and polarity.
- (iii) Verification of all individual parts / components of the Current Transformer so as to ensure to have complied the above specification.
- (iv) Measurement of Insulation Resistance.
- (v) Power Frequency Dry withstanding Test on Primary and Secondary winding including primary intersections.
- (vi) Over – Voltage Interturn test.
- (vii) Partial discharge Test
- (viii) Knee point voltage and Excitation current measurement for 'PS' class cores.
- (ix) Secondary winding resistance measurement.
- (x) Determination of errors.
- (xi) ISF Test.
- (xii) Leakage Test.
- (xiii) Magnetization Characteristics of the Current Transformers.
- (xiv) Turn ratio error on 'PS' class cores.
- (xv) Measurement of capacitance
- (xvi) Measurement of tan delta at 0.3, 0.7, 1.0 and $1.0 \text{Um}/\sqrt{3}$ for 33KV C.Ts.

- The Method For Conducting Partial Discharge Test.

The test circuit for the measurement of partial discharge (PD) should have been in accordance with sub-clause 4.2 of IEC-270. The applied voltage should be raised to the rated voltage of the Current Transformers and should have been maintained for a period greater than or equal to 10 seconds. The voltage should have been reduced to measuring voltage as specified in the IS and maintained for a period greater than or equal to 1 minute. The PD should not exceed 10 Pico-coulombs.

7.0 INSPECTION :

7.1 The Owner shall have access at all times to the works and all other places of manufacture, where the Current Transformers are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting the necessary tests.

7.2 The supplier shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection.

7.3 No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected, tested and despatch clearance issued. However, the Owner reserves the right to alter the despatch schedule, attached to this specification without any extra financial liability to OPTCL.

7.3.1 The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

8.0 DOCUMENTATION :

8.1 All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. units.

8.2 The supplier shall furnish four sets of following drawings/documents along with his offer for 0.2 accuracy class metering core CTs.

- (a) General outline and assembly drawings of the Current Transformers.
- (b) Sectional views showing.
 - (i) General constructional features.
 - (ii) Materials / gaskets / sealing used.
 - (iii) The insulation of the winding arrangement, method of connection of the primary / secondary winding to the primary / secondary terminals etc.
- (c) Schematic drawing
- (d) Rating and Diagram plate.
- (e) Secondary Terminal Box.
- (f) Assembly Sectional view of Primary Terminal
- (g) Assembly drawing for secondary terminal.
- (h) The detailed dimensional drawing of Porcelain Housing such as ID, OD, thickness and Insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- (i) Sectional view of Pressure Release device.
- (j) Drawing showing details of Oil level Indicator.
- (k) All type and special test reports relating to tests, as mentioned at Cl. No. 6.1 of this Technical Specification.

- (l) Ratio and phase angle error curves for CTS.
- (m) Magnetization characteristic curves such as B-H curves and sp.loss vs. flux density curves.
- (n) Drawings for Terminal Connector.

9.0 TEST REPORTS:

- (i) A set of type test and special test reports if any shall be furnished to the Owner during detailed Engineering & drawing approval.
- (ii) Copies of acceptance test reports and routine test reports shall be furnished to the Owner. One copy will be returned, duly certified by the Owner and only thereafter shall the materials be despatched.
- (iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Owner.
- (iv) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required by the Owner.

CHAPTER - E5 - 5

TECHNICAL SPECIFICATION

FOR

33kV & 11 kV OUT DOOR IVT

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OF
INDUCTIVE VOLTAGE TRANSFORMER**

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TECHNICAL SPECIFICATION FOR 33 & 11KV INDUCTIVE VOLTAGE TRANSFORMER

1.0 SCOPE :

This specification provides for the design, manufacture, assembly inspection and testing at the manufacturer's works, packing and delivery FOR [Destination] of outdoor mounted type, single phase, single unit type Inductive voltage transformers for 33kV & 11 kV systems to be used for voltage indication, supply of potential to tariff meters, relays for feeder protection in 33/11 KV Sub-station.

- 1.1 The design of Inductive voltage transformers shall be such that its accuracy shall not be affected by the presence of pollution on the external surface of its insulators.

The voltage transformer shall operate satisfactorily in system with high **X/R** ratio.(Tp=100ms)
Voltage transformer tanks along with top metallics shall be galvanised and painted to required shade stipulated under relevant sections of the specification.

- 1.2 The IVTs shall be complete in all respects with insulators, bimetallic connectors, fixing details etc. as described herein and Technical Requirement Table I.

2.0 STANDARDS:-

- 2.1 The IVTs shall conform in all respects to high standards of Engineering, design, workmanship and latest revisions of relevant standards at the time of offer and the Owner shall have the power to reject any work or material which in his judgement is not in full accordance therewith.
- 2.2 Except to the extent modified in the specifications, the IVTS shall conform to the latest editions and the amendments of the standards listed hereunder:

Sl. No.	Standard Ref. No.	Title.
01	IEC-44(4)	Instrument Transformer – measurement of PDS.
02	IEC-60	High voltage testing techniques.
03	IEC-171	Insulation co-ordination.
04	IEC-186	Voltage Transformers.
05	IEC-186(A)	Voltage Transformers (first supp. to IEC-186)
06	IEC-270	Partial discharge measurement.
07	IS-335	Insulating oil for transformers and switch gears.
08	IEC-8263	Method for RIV Test on high voltage insulators.
09	IS-2071	Method of high voltage testing.
10	IS-2099	High Voltage porcelain bushings.
11	IS-2147	Degree of protection provided by enclosures for low voltage switch-gear and control.
12	IS-2165	Insulation co-ordination for equipments of 100KV and above.

13	IS-3156 (Part-I to IV).	Voltage transformers.
14	IS-3347	Dimensions of porcelain transformer bushings.
15	IS-4146	Application guide for voltage transformers.
16.	IS-5547	Application guide for Capacitor Voltage Transformers.
17.	IS-9348	Coupling Capacitor & Capacitor Devices.

2.3 All the above along with the amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this Technical Specification will prevail.

3.0 CLIMATIC AND SERVICE CONDITIONS:

Please refer chapter- E3 of Technical Specification on climatic conditions.

4.0 OWNER'S AUXILIARY POWER SUPPLY:-

4.1 Following power supplies shall be made available at site:

- (a) AC-3 phase, 415V, 50HZ
- (b) AC single phase, 240V, 50HZ
- (c) 220V/48V DC.

4.2 All equipment and devices shall be capable of continuous satisfactory operation on AC and DC supplies of nominal voltage, mentioned above with variations as given below.

- (a) AC voltage variation. $\pm 10\%$
- (b) Frequency variation. - 5% to +3%
- (c) Combined voltage & frequency variation $\pm 10\%$

5.0 INSTALLATION:-

The VTS covered under this specification shall be suitable for outdoor installation without any protection from rain, dust, mist and direct rays of the sun.

6.0. GENERAL TECHNICAL REQUIREMENTS FOR IVT:-

6.1 Each IVT shall be supplied, filled with insulating oil and shall be hermetically sealed to prevent atmosphere coming in contact with oil, avoiding filtration and change of oil. In case the tenderer intends to use Nitrogen or any other inert gas above the oil level, the gas must not leak out and the same shall be stated in the tender.

6.2 However, the IVT shall have a provision for draining and filling insulating oil after drying or preferably must have arrangement for drying the oil by continuous process with oil filters.

6.3 The IVT shall be suitable for transport in horizontal position if the transport limitations so demand.

7.0 SECONDARY TERMINAL BOX:-

- 7.0.1 The secondary terminals shall be brought out in a weather proof terminal box with a rating not less than IP-55.
- 7.0.2 All secondary terminals shall be brought out in a compartment on one side of each IVT for easy access. The exterior of this terminal box shall be Aluminum extruded sheets.
- 7.0.3 The terminal box shall be provided with removable gland plate and glands suitable for 1100 volts grade. PVC insulated, PVC sheathed multi core 4 sq.mm to 6 sq.mm stranded copper conductor cable.
- 7.0.4 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing/locking arrangement and shall be suitable to prevent penetration of moisture and rain water.
- 7.0.5 The dimensions of the terminal box and its openings shall be adequate to enable easy access and sufficient working space for use of normal tools.
- 7.0.6 The terminal blocks shall be standard type and provided with ferrules indelibly marked or numbered and their identifications shall correspond to the designation on the relevant wiring diagram.
- 7.0.7 Secondary wiring terminal studs shall be provided with at least three nuts, plain and spring washers. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads.

Polarity shall be indelibly marked on each primary and secondary terminal.

- 7.1 The IVT shall be filled with oil under vacuum after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and/or oil sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the IVT. The method, adopted for hermetic sealing shall be described in the offer.
- 7.2 The castings of base, collar etc. shall be diecast and tested before assembly to detect cracks and voids, if any.
- 7.3 The characteristics of the IVTS shall be such as to provide satisfactory performance such as voltage error and phase displacement at rated frequency shall not exceed the values as per relevant standards at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden at a power factor of 0.8 lagging. The error shall be determined at the terminals of the IVT and shall include the effects of any fuses or resistors as an integral part of the IVT.

7.4 Inductive voltage transformers shall be designed so as to achieve the minimum risk of explosion in service. The bidder shall bring out in his offer, measures taken to achieve this.

8.0 PRIMARY WINDING:-

Primary winding of the IVT will be connected phase to neutral with the neutral point solidly earthed. The arrangement for this shall be included in the scope of supply. The primary conductor shall be of adequate cross-section so that the maximum permissible current density shall not be exceeded even during short-circuit conditions.

9.0 SECONDARY WINDING.

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. The secondary conductor shall be of adequate cross section so that the maximum permissible current density shall not be exceeded even during short- circuit conditions. Each 33 & 11 KV IVT will have two secondary windings, **protection-15 VA; –Metering-15 VA –**burden at 0.8 lagging power factor and rated voltage of 110V/1.732V for protection and 110/1.732V for metering winding. Secondary windings shall be used for metering, relaying and synchronizing. Each winding shall comply requirements of both Part-II and III of up-to-date editions of IS-3156/IEC-186.

10.0 CORE:- Core laminations shall be of cold rolled grain oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure accuracy i.e. 0.2 accuracy class at both normal and high over voltage. The core material , thickness of lamination, the relevant graphs showing the characteristics of the core materials shall be submitted along with the offer.

11.0 TANK.

11.1 Both expansion chambers and tanks of the IVT shall be made of high quality steel and shall be able to withstand full vacuum and pressure, occurring during transit and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be hot- dip galvanized as per relevant standard.

11.2 The metal tanks shall have bare minimum number of welded joints so as to minimize possible locations of oil leakage. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from the Owner for any horizontal welding, used in the bottom tank

11.3 Paint inside the metallic housing shall be of anti-condensation type.

12.0 PORCELAIN HOUSING.

- 12.1. The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength, Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rain water or condensed water particles(fog).The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.
- 12.2.The bushings of the IVTS shall conform to latest edition of IS-2099.The hollow porcelain insulators shall conform to the latest edition of IS-5621
- 12.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength
- 12.4. The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.
- 12.5 Cast metal and caps for the bushings shall be of high strength hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.
- 12.6 The insulation of bushings shall be co-ordinated with that of the IVT such that the flashover, if any, shall occur only external to the IVT.
- 12.7 Oil level gauge and convenient means of filling, sampling and draining of oil shall be provided.
- 12.8 End shields should be provided for distribution of stresses.
- 12.9 Corona shields for bushings, if required, should be provided.

13.0 INSULATING OIL.

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall comply in all respects with the provisions of the latest edition of IS-335. The IVTS shall be supplied completely filled with purified oil.

14.0 PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:-

The supplier shall ensure that the sealing of the IVT is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings

- (a) Locations of emergence of primary & secondary terminals..
 - (b) Interface between porcelain housing and metal tank(s).
 - (d) Cover of the secondary terminal box.
- 14.1 Nuts and bolts or screws used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.

14.2 For gasket joints, wherever used, nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

15.0 FITTINGS AND ACCESSORIES

15.1 Fittings and accessories, listed below shall be supplied with each IVT. Any fitting, required essential other than those listed below shall also be supplied along with each IVT.

- (a) Oil level gauge.
- (b) Oil filling hole and cap.
- (c) Pressure relieving device.
- (d) Lifting lugs for core and windings, bushings & complete transformers.
- (e) Phase terminal connectors.
- (f) Tank earthing pads/terminals with necessary nuts and bolts and washers for connecting to Owner's strip.
- (g) Name/Rating plate.
- (h) MCB & H.R.C. fuse

15.2 OIL LEVEL GAUGE:- An oil level gauge shall be provided to indicate the oil level in the IVT. This gauge shall be mounted in such a way that the oil level can be seen from the ground level.

15.3 PRESSURE RELIEVING DEVICE: - Each IVT shall be provided with a pressure relieving device so as to protect bushing of the IVT even under unfavourable conditions.

15.4 OIL DRAIN COCK: - An oil drain cock alongwith a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

15.5 EARTHING:- Metal tank of each IVT shall be provided with two separate earthing terminals for bolted connection to 50mm x 6mm flat to be provided by the Owner for connection to station earth-mat.

15.6 LIFTING ARRANGEMENT: - The IVT shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement [Lifting eye] shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

15.7 NAME PLATE: - The IVT shall be provided with non-corrosive legible name plate with the information specified in relevant standards, duly engraved/punched on it.

15.8 GASKET JOINT: - The manufacturer shall furnish the type of gasket used or setting methods.

15.9 TERMINAL CONNECTORS: - All the IVTS shall be provided with bimetallic solderless clamp type, rigid type terminal connectors, suitable for AAAC 150 sq mm for 33 KV & 100 sq mm for 11 KV.

Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors/station bus bar.

15.10 TERMINAL CONNECTORS shall be manufactured and tested as per IS:5561.

15.11 All castings shall be free from blow holes, surface blisters, cracks and cavities.

All sharp edges and corners shall be blurred and rounded off.

15.12 No part of a clamp shall be less than 10mm thick.

15.13 All ferrous parts shall be hot dip galvanized conforming to IS-2633.

For bimetallic connectors, copper alloy linear of minimum thickness of 2 mm shall be cast integral with aluminium body.

15.14 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

15.15 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS-5561.

15.16 SECONDARY WIRING:-

The Secondary wiring shall be enclosed in conduits and shall be brought to a terminal block ready for external connections. The wiring shall be of adequate cross-section and not less than 4.00 sq.mm copper wire.

15.17 The supplier shall supply necessary hardware, required for connection of phase side conductor to the line terminal and the grounding strip to the grounding terminal.

15.18 Necessary nuts and bolts for fixing the IVTS on the supporting structures shall be in tenderer's scope of supply.

16.0 TESTS:-

16.1 **Type Tests:** - The offered 33 & 11 KV Inductive voltage transformer should have been subjected to the following type tests in a Government approved Test Laboratory. The bidder shall furnish the type test reports during detailed Engineering & approval of Drawing. These tests must not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and to the design/type offered against this specification, the Owner reserves the right to demand repetition of some or all type tests/special tests without any extra cost to OPTCL in the presence of Owner's representative at the cost of the supplier.

For 33 & 11 KV IVT:

- (a) Temperature rise test.
- (b) Short circuit withstand capability test.
- (c) Lightning Impulse Test.

- (d) High Voltage power frequency wet withstand voltage tests.
- (e) Determination of errors.
- (f) IP-55 Test on secondary Terminal Box.

N.B.:- [I] The dielectric type tests should have been carried out on the same transformer.

- (ii) After the IVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.
- (iii) For Temperature Rise Test, the test must have been made with the appropriate rated burden, connected to each secondary winding.

16.2 ROUTINE TESTS:- The following routine tests shall be conducted on each VT in the presence of Owner's representative for which no charges will be payable by OPTCL. No sampling is allowed.

- (a) Verification of terminal markings.
- (b) Power frequency withstand tests on primary windings/capacitor voltage divider for IVT
- (c) Partial discharge measurement.
- (d) Power frequency withstand tests on secondary windings/Low voltage terminal.
- (e) Power frequency withstand tests between sections.
- (f) Determination of errors on complete.
- (g) Measurement of Insulation resistance.
- (h) Oil leakage test.
- (i) Measurement of capacitance and dielectric dissipation factor before and after dielectric tests (as per IEC-358)
- (j) Any other test as per relevant national & international standards.

N.B.:- Determination of errors shall be performed after the other tests. The standard reference VT to be used during testing for determination of ratio error and phase angle error should of 0.05 accuracy class or better as per standard practice, presently adopted by OPTCL.

17.0 INSPECTION: As specified in the GCC and Chapter E2 of the Technical Specification

18.0 DOCUMENT: The contractor shall furnish four sets of following drawings/documents within one month of the LOA .

- [a] General outline and assembly drawings of the Inductive Voltage Transformers
- [b] Sectional views showing:-
 - [i] General constructional features.
 - (ii) Materials/gaskets/sealing used.
 - iii] The insulation of the winding arrangements, method of connection of primary/secondary winding to the primary/secondary terminals etc.
- [c] Schematic drawing.

- [d] Rating & diagram plate as per relevant IEC/ISS
- [e] Secondary Terminal Box.
- [f] Assembly Sectional view of Primary terminal
- [g] Assembly drawing for secondary terminal
- [h] The detailed dimensional drawing of Porcelain Housing such as ID,OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- [i] Sectional view of pressure release device.
- [j] Drawing showing details of Oil level.
- [k] All type test reports relating to the tests as specified in Clause-8.1 of the above.
- [l] Ratio and phase angle error curves for IVTS.
- [m] Magnetization characteristic curves such as B-H curves and Sp. Loss vs. Flux density curves for core material, used for IVT.

19.0 TEST REPORTS:-

- [i] Type test reports shall be furnished to the Owner during detailed Engg & approval of drawing.
 - [ii] Copies of acceptance test reports and routine test reports shall be furnished to the Owner. One copy will be returned, duly certified by the Owner and only thereafter shall the materials be despatched.
 - [iii] All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Owner.
 - [iv] All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the Owner.
- 21.1 The necessary galvanized flanges, bolts etc. for the base of the Inductive Voltage Transformers shall be supplied without any extra cost to the Owner.

CHAPTER – E5- 6

TECHNICAL SPECIFICATION

FOR

OUT DOOR SURGE ARRESTERS (33kV & 11kV)

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OF
SURGE ARRESTERS

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SURGE ARRESTERS

TECHNICAL SPECIFICATION FOR SURGE ARRESTERS

1.0 SCOPE

This Specification provides for the design, manufacture, inspection and testing before dispatch, packing and delivery F.O.R. (destination) of **Metal Oxide (gapless)** Surge Arresters with discharge counters, POLYMER insulating base, (Discharge Counter at Insulating Base on 33KV side only and there shall not be any discharge counter on 11kV side), terminal connectors and other accessories as specified here in.

The Surge Arrester shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and Owner shall have the power to reject any work or materials, which in his judgement is not in full accordance therewith.

2.0 STANDARDS:-

Except to the extent modified in the Specification, the Surge Arrester shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title.
1	IEC-99-4	Specification for Surge Arresters without gap for AC System.
2	IS:2147	Degree of protection, provided by enclosures for low voltage switchgear and control.
3	IS:2629	Recommended practice for hot dip galvanization of iron and steel.
4	IS:2633	Method for testing uniformity of coating on zinc coated articles.
5	IS:3070	Specification for surge arresters for alternating current system.
7	IEC-60-1	High-Voltage Test technique.
8	IEC-270	Partial discharge measurements.
9	IEC-99-1	Non-linear resistor type gapped arresters for a.c. systems.

10		Indian Electricity Rules, 1956.
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3.0 GENERAL TECHNICAL REQUIREMENTS :

The Surge Arrester shall confirm the technical requirements

The energy handling capability of each rating of Arrester offered, supported by calculations, shall be furnished with the offer.

The Surge Arresters shall be fitted with pressure relief devices and arc diverting paths and shall be tested as per the requirements of IEC for minimum prospective symmetrical fault current as specified in Appendix-I.

A grading ring shall be provided if required, (for attaining all the relevant technical parameters) on each complete Surge Arrester.

4.0 PROTECTIVE LEVELS :

Surge Arresters shall be capable of providing protection to sub-station equipments, designed for the withstand levels, given in the following table.

Sl. No.	Equipment to be protected	Insulation Level of 36KV System	Insulation Level of 12KV System
		BIL (kV _{peak})	BIL (kV _{peak})
1	Power Transformers.	170	75
2	Instrument Transformers.	170	75
3	Reactors	170	75
4	Circuit Breakers/Isolators.		
(i)	Phase to ground.	170	75

Surge arrester shall be suitable for the following duty cycles of circuit breaker at the following system voltages:

36 kV Circuit Breaker	O-0.3 sec-CO-3 min-CO
12 kV Circuit Breaker	O-0.3 sec-CO-3 min-CO

5.0 DUTY REQUIREMENT :

Surge Arresters shall be of heavy-duty station class and gapless type without any series or shunt gaps.

- i. Surge Arresters shall be capable of discharging over voltages occurring during switching of un-loaded transformers, lines, capacitors and reactors.
- ii. The Surge Arresters shall be capable of discharging lightning and switching surges and temporary power frequency over-voltages.
- iii. The Surge Arresters shall be capable of discharging the energy equivalent to class 3 of IEC-99-4.

The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The supplier shall submit values and the supporting evidence along with calculations on above. Surge Arresters shall be fully stabilized thermally to give a life expectancy as per standard under site conditions. Surge Arresters shall be able to withstand maximum wind velocity. Surge Arresters shall be capable of withstanding effects of direct solar radiation. Surge arresters shall be capable of spark over on severe switching Surges and multiple strokes.

The Surge Arrester should be adequately designed to operate satisfactorily under temporary power frequency over-voltage as given in specific technical requirements, after discharging two shots of respective long duration surges.

Unless otherwise brought out separately by the Bidder in the schedule of deviations, the Surge Arresters, offered shall conform to the specification scrupulously. All deviations from the specification shall be brought out in the schedule of deviations. The discrepancies between the specification and the catalogues or literature, submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

6.0 CONSTRUCTION :

Non linear blocks shall be sintered metal oxide material. These shall be provided in such a way as to obtain robust construction with excellent electrical and mechanical properties even after repeated operations. All the units of arresters of same rating shall be inter-changeable without adversely affecting the performance. The Surge Arresters shall be suitable for pedestal type mounting. All the necessary flanges, bolts, nuts, clamps etc. required for assembly of complete arrester with accessories and mounting on support structure to be supplied by the Contractor. The drilling details for mounting the Arrester on OPTCL/DISTCOM's support shall be supplied by the OPTCL/DISTCOM.

The minimum permissible separation between the Surge Arrester and any earthed object shall be indicated by the Bidder in his offer. Surge Arresters shall be designed

to incorporate pressure relief devices and arc diverting paths to prevent shattering of the blocks or the porcelain housing, following prolonged current flow or internal flash over and providing path for flow of rated fault currents in the event of arrester failure. Surge Arresters shall incorporate anti-contamination feature to prevent arrester failure, caused by uneven voltage gradient across the stack, resulting from contamination of the arrester porcelain. Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer, formed across each block are to be furnished. Metalised coating thickness for reduced resistance between adjacent discs is to be furnished along with the procedure for checking the same. Details of thermal stability test for current distribution of current on individual disc is to be furnished.

Each individual unit of Surge Arresters shall be hermetically sealed and fully protected against ingress of moisture. The hermetic seal shall be effective for the entire lifetime of the arrester and under the service conditions as specified. The supplier shall furnish sectional view of the arrester showing details of sealing employed. The Surge Arresters shall be suitable for hot line washing.

7.0 POLYMER INSULATION HOUSING :

All polymer Housings shall be free from lamination cavities or other flaws, affecting the maximum level of mechanical and electrical strengths. The minimum creepage distance of the arrester housing shall be as per CI 7.21 of the TS.

8.0 GALVANISATION, NICKEL PLATING ETC.

All ferrous parts exposed to atmosphere shall be hot dip galvanized as per IS: 2629, as amended from time to time. **Tinned copper/brass lugs shall be used for internal wiring of discharge counter** (on 33kV side only). Screws used for electrical connections shall be either made of brass or shall be nickel-plated. Ground terminal pads and nameplate brackets shall be hot dip galvanized. The material shall be galvanized only after completing all shop operations

9.0 ACCESSORIES AND FITTINGS

9.1 Surge Counters

A self- contained Surge counter, suitably enclosed for outdoor use and requiring no auxiliary of battery supply for operation shall be provided for each unit on 33 kv side. The surge counter shall be operated by the discharge current, passed by the surge arrester and shall be suitable for mounting on the support structure of the Arrester.

Surge counters shall be of the Electro-mechanical type and designed for continuous service. The cyclometer counter shall be visible through an inspection window from ground level. The counter terminals shall be robust and adequate size and shall be so located that the incoming and outgoing connections are made with minimum possible bends. Internal parts shall be unaffected by atmospheric conditions at site. Alternatively, a weather proof housing to IP 55 shall be provided and this shall be designed to allow the recording device to be read from ground level without exposing the internal parts to the atmosphere.

The Surge Counter shall be connected in the main earth lead from the arrester in such a manner that the direction of the earth lead is not changed or its surge impedance materially altered. A bolted link shall be provided so that the surge counter may be short circuited and removed without taking the arrester out of service. All necessary accessories and earthing connection leads between the bottom of the Arrester and discharge counter Surge Arrestor shall be with Discharge Counter at Insulating Base (Discharge Counter on 33KV side only and there shall not be any Discharge Counter on 11KV Surge Arrestor), shall be in the Contractor's scope of supply.

10.0 LEAKAGE CURRENT METERS : (In case of 33 kV Surge Arrester only)

Leakage current meters (suitable milli-ammeter) shall be connected in the earthing path of the surge arresters to measure the resistor grading leakage current. Meters shall be designed for continuous service.

The ammeter shall be suitable for mounting on the support structure of the arrester. The push buttons shall be mounted such that it can be operated from the ground level.

The internal parts shall be fully weather - proof to IP 55 or better with a transparent cover to provide an unobstructed view of the ammeter. Arresters shall be complete with insulating base having provision for bolting to flat surface of the structure. The grounding terminals shall be suitable for accommodating grounding connection to steel earth mat.

Clamp type terminal connector, suitable for AAAC conductor of 148 Sq mm & 100 Sq mm shall be provided having both horizontal and vertical take-off. Two clamp type ground terminal connectors, suitable for G. I. Strip (50 x 6) should be provided. All interconnecting hardware such as nuts, bolts, spring washers etc. with 5% spares shall be supplied for different units. Pollution Shunt (Copper braid) shall be supplied along with each Surge Arrester for by-passing the surface current. Other standard accessories, which are specifically not mentioned, but are usually provided with Surge Arrester of such type and rating for efficient and trouble free operation should be supplied.

11.0 NAME PLATE :

Each single pole Arrester shall be provided with non-corrosive legible name plate, at the base bearing thereon, voltage rating of the complete pole and the number of demountable sections with the following data, indelibly marked

- (a) Name of the OWNER
- (b) Contract order No. & Date.
- (c) Name of device.
- (d) Manufacturer's name and trademark and identification no. of the arrester being supplied.
- (e) Year of manufacture
- (f) Rated voltage
- (g) Rated Frequency
- (h) Maximum continuous operating voltage.
- (i) Type
- (j) Nominal discharge current.
- (k) Long duration discharge class.
- (l) Pressure relief current in KA(rms)
- (m) Energy discharge capability (KJ / KV rating).

12.0 TEST :

12.1 Type Tests:

The surge Arrester offered should have been subjected to the following **Type tests** in an independent Government approved test laboratory. The bidder shall furnish four sets of type test reports along with the drawings for approval. These tests must not have been conducted earlier than five years from the date of opening of technical bid. For any change in the design type, already type tested and the design type offered against this specification, the Owner reserves the right to demand repetition of some or all type tests without any extra cost and in presence of Owner's representative at the cost of the Contractor.

1 Insulation withstands tests :

- (a) Lightning Impulse Voltage Test.
- 2 Residual voltage tests.
- 3 Long duration current impulse withstand tests.
- 4 Operating duty tests.
- 5 Pressure relief tests.
 - (a) High current test.
 - (b) Low current test.
- 6 Power frequency voltage vs. time curve.

(Temporary over voltage test)

- 7 Contamination test. (artificial pollution test).
- 8 Seismic withstand test.
- 9 IP-55 test on surge counter.
- 10 Minimum current operation tests of the surge counter.
- 11 Maximum current withstand test of the surge counter.
- 12 Mechanical terminal load test on bushing.
- 13 Partial discharge test.

N.B. :-Even if the condition i.e. the dry arcing distance or the sum of the partial dry arcing distances is larger than the test voltage divided by 500 KV/m', the lightning impulse voltage test must have been conducted or is to be conducted without any financial liability to OPTCL.

12.2 ROUTINE TESTS :

The following **Routine tests** shall be conducted at the supplier's cost on each Surge Arrester and shall be submitted along with or before offering for inspection for Owner's approval.

- (a) Measurement of reference voltage.
- (b) Residual voltage tests.
- (c) Measurement for partial discharge and contact noise.
- (d) Sealing test for units with sealed housings.

12.3 ACCEPTANCE TESTS :

The following tests, considered as **Acceptance tests**, shall be conducted in the presence of Owners representative for which no charges will be payable by Owner. The acceptance tests, whenever possible shall be conducted on the complete arrester unit. The number of samples to be subjected to acceptance test shall be decided by the Owner at the time of actual testing.

- I Temperature Cycle Test on Housing.
- II Measurement of Power Frequency Voltage at the reference current.
- III Measurement of leakage current and capacitive current at M.C.O.V.
- IV Lightning Impulse Residual Voltage Test at N.D.C., 50% of N.D.C. & 200% of N.D.C.
- V Partial Discharge Tests on complete arresters/units at 1.05 times M.C.O.V.
- VI Special Thermal stability test.
- VII Tests on polymer insulating base
- VIII Galvanization test on metal parts.

- IX The functional (operational) test on the Surge Counter by way of checking its operation at following nominal discharge currents :
- a) 100 Amps with 8/20 micro second wave shape.
 - b) 10 KA with 8/20 micro second wave shape for 33 kV Surge Arrestor
 - c) 5 KA with 8/20 micro second wave shape for 11 kV Surge Arrestor
- X Check of calibration of leakage current meters.

13.0 INSPECTION : As specified in the GCC of Volume-I and Chapter- E2 of Volume-II of the technical specification.

14.0 DOCUMENTATION :

All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units. The supplier shall furnish two sets of following drawings / documents within one month of LOA.

- (i) General outline drawings of the complete Arrestor with technical parameters.
- (ii) Drawings showing clearance from grounded and other line objects and between adjacent poles of Surge Arresters, required at various heights of Surge Arresters.
- (iii) Drawings showing details of pressure relief devices.
- (iv) Detailed drawing of discharge counters along with the wiring and schematic drawing of discharge counter and meter.
- (v) Outline drawing of insulating base.
- (vi) Details of grading rings, if used.
- (vii) Mounting details of Surge Arresters.
- (viii) Details of line terminal and ground terminals.
- (ix) Volt-time characteristics of Surge Arresters.
- (x) Details of galvanization being provided on different ferrous parts.
- (xi) The detailed dimensional drawing of porcelain Housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.

- (xii) Cross-sectional view of the Surge Arrester Units showing all components.

15.0 TEST REPORTS :

- (i) The front page of type the test reports signed by the bidder shall be furnished to the Owner with the tender specification. The full copy of the type test reports shall be furnished within one month of LOA.
- (ii) Copies of acceptance test reports and routine test reports shall be furnished to the Owner.
- (iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Owner.
- (iv) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the Owner.

CHAPTER – E5 - 7

**TECHNICAL SPECIFICATION
FOR
OUT DOOR
33 KV & 11 KV ISOLATOR**

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OF
ISOLATOR

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TECHNICAL SPECIFICATION FOR 33 KV & 11 KV ISOLATOR

1.0 SCOPE

This specification provides for design, manufacturer, testing at manufacturer's Works and delivery ,supervision of erection, commissioning of outdoor station type 33kV & 11kV, 3 phase triple pole double break gang operated centre rotating type (Single Isolator with / without earth switches (as per Drg. No. ODSSP/SS/12 & ODSSP/SS/14 for 33kV & ODSSP/SS/13 & ODSSP/SS/15 for 11kV respectively), with electrical interlock (castle key), insulators and complete in all respect with bimetallic connectors arcing horns operating mechanism, auxiliary switches, indicating devices, fixing detail etc. as described hereinafter. Double Tandem operating GI pipes (40mm Dia. medium gauge) & down pipe of 50mm dia, medium gauge GI pipe has to be used.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

1.1 Main features

Sl.No	Type	33kV	11kV
1	Main switch	Double end break Centre post rotating, gang operated	
2	Service	Outdoor	
3	Applicable standard	IS : 9921 / IEC-129/IEC-62271-102	
4	Pole	3 pole gang operator	
5	Rated voltage nominal/ Maximum	33/36 kV	11/12 kV
6	Rated Frequency	50 Hz -5% to +3%	
7	System earthing	Effectively earthed	
8	Temperature rise	As per relevant IS/IEC publication	
9	Insulation level impulse with stand voltage		
	a) Across Isolating distance	195 kV _{peak}	85 kV _{peak}
	b) To earth & between poles	170 kV _{peak}	75 kV _{peak}
10	1 minute power frequency with stand voltage		
	a) Across Isolating distance	80 kV _{peak}	32 kV _{peak}
	b) To earth & between poles	70 kV _{peak}	28 kV _{peak}
11	Rated current in Amp	1250	800

12	Short time current for 3 sec	25kA	25kA
13	Operating mechanism	Manual	Manual
14	Auxiliary voltage	33kV	11kV
	a) Control & Inter lock	48 DC 80% to 110%	
15	Safe duration of overload		
	a)150% of rated current	5 minute	
	b)120% of rated current	30 minute	
16	Minimum creepage distance of support and Rotating insulator	900mm	500mm
	i) Mounting structure	Upright on G.I structure	
	ii) Terminal connector type	Bimetallic clamp size as per	
	iii) Control	Local	

IMPORTANT NOTE:

The operating mechanism for 33kV main switch of isolator shall be motorized operation but 11 kV main switch and both 33 kV & 11 kV earth switch shall be manual operated.

2.0 STANDARDS

Disconnecting switches covered by this specification shall conform to latest edition IEC-129/IEC 62271-102 I.S.1813 and IS: 9921,IS-325,and unless specifically stated otherwise in this specification.

3.0 TYPE

The 33kV & 11kV Isolators shall be outdoor type with three phase double break centre rotating type [Single Isolator(SI) with/without E/S] Isolators suitable for manual/electrical(motorized) operation at Remote/ local end. They shall have crank and reduction gear mechanism.

All Isolators offered shall be suitable for horizontal upright mounting on steel structures. Each pole unit of the multiple Isolators shall be of identical construction and mechanically linked for gang operation.

Each pole of the Isolator shall be provided with two sets of contacts to be operated in series and the moving contact blades shall rotate in horizontal plane.

The design shall be such that the operating mechanism with the linkages shall be suitable for mounting on any of the outer pole ends without much difficulty and with minimum shifting of parts.

Moving contacts of all isolators shall rotate through 90 deg from their “fully closed position” to “fully open position so that the break is distinct and clearly visible from ground level.

The **33kV & 11kV** Isolators offered by the Bidder shall be designed for Normal rating current for **1250 amp**. It should be suitable for continuous service at the system voltages specified herein.

The Isolators shall be suitable to carry the rated current continuously and full short circuit current of 25kA for 33kV & 11kV respectively for 3 second at site condition without any appreciable rise in temperature. These shall also be suitable for operation at 110% rated (normal) voltage. The Isolators shall be suitable for Isolating low capacitive / inductive currents of 0.7amp at 0.15 power factor. The isolators shall be so constructed that they don't open under the influence of short circuit conditions.

The Isolators and earthing switches are required to be used on electrically exposed installation and this should be taken into account while fixing the clearance between phases and between phase and earth.

4.0 MAIN CONTACTS & MOVING ARM

All Isolators shall have heavy duty, self aligning and high pressure line type contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper strips with 5 mm minimum thickness and proper contact area. Also current density to be assured @ $1 \text{ mm}^2 = 1.5 \text{ Amp}$. Fixed contact should consist of loops of above copper strips suitable for 1250 Amps ratings for 33kV & 11kV Isolators. The hard dawn electrolytic copper strips should be silver plated 10 micron thickness or more as per the requirement and fixed contacts should be backed by powerful phosphor bronze/stainless steel springs of suitable numbers. However, the thickness and contact area of the contact should conform to the drawing approved during type test.

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current of 25kA for 33kV & 11kV for 3 seconds without any appreciable rise in temperature. The Isolator blades shall retain their form and straightness under all conditions of operation including all mechanical stress arising out of operation as well as under rated short circuit condition.

Fixed guides shall be provided so that even when the blades are out of alignment by one inch (maximum), closing of the switches, proper seating of the blades in between contacts and adequate pressure to give enough contact surface is ensured. Wherever possible, the blades shall be counter balanced by weights and springs. The contact shall be self cleaning by the wiping action created by the movements of the blades. The surface of the contacts shall be tendered smooth and silver plated.

The Isolator shall be self cleaning type so that when isolator remain closed for long periods in a heavily polluted atmosphere, binding does not occur. No undue wear or scuffing shall be evident during the mechanical endurance

tests, contacts and springs shall be designed so that adjustment of contact pressure shall not be necessary throughout the life of the isolator. Each contact or part of contacts shall be independently sprung so that full pressure is maintained on all contact at all times.

5.0 ARCING HORN AND GRADING HORN

Suitable arcing horn made of tinned electrolytic copper which are required for guiding contacts shall be provided on the fixed and moving contacts of all Isolators. The contacts shall be of 'make before and break after' type.

6.0 ELECTRICAL INTERLOCK / MECHANICAL INTERLOCK

The disconnecting switches whenever required shall be with an approved type electrical interlock for interlocking with the associated circuit breakers and earth switch. Electrical interlock assembly should be more rigid in construction and properly mounted to ensure reliable operation. The design should be such that the electrical circuit for the interlocking mechanism will only remain energised during operation of the switches.

7.0 AUXILIARY SWITCHES

All isolators and earthing switches shall be provided with 48V DC auxiliary switches for their remote position indication on the control board and for electrical interlocking with other equipment. The auxiliary switch shall be provided with a minimum of auxiliary contacts normally 4 open and normally 4 closed contacts with 10 amp. Current carrying capacity.

8.0 EARTH SWITCH

Line earth switch shall consist of three earthing blades for Isolator which normally rest against the frame when the connected Isolator is in closed position. The earthing blades for three phase shall be mechanically linked to a coupling shaft which shall be capable of being fitted on either side of the Isolator. The earthing blades shall match and be similar to the main switch blades and shall be provided at the hinge; with suitable flexible conductors with terminal lugs for connecting to the station ground bus. The earthing blades shall be operated by a separate mechanism but shall be mechanically interlocked with the main switch so that the earthing blades can be closed only when the main switches are in open position and vice-versa. The earthing blades shall be gang operated and all the three blades will operate simultaneously.

9.0 OPERATING MACHANISM

The operating mechanism shall be simple and shall ensure quick and effective 1000 operation. The design shall be such as to enable one man to operate it

with nominal effort. The operating mechanism box shall be made out of Aluminum extruded (Aluminum Alloy) sections of minimum 3mm thickness.

The Isolator blades shall be in positive continuous control throughout the entire cycles of operation. The operating rods and pipes shall be rigid enough to maintain positive control under most adverse conditions and to withstand all torsional and bending stresses arising from operation. Operation of the switches at any speed should not result in improper functioning, in displacement of parts / machines after final adjustment has been made. All holes in cranks, linkages etc. having moving pins shall be drilled and fitted accurately so as to prevent slackness and lost motion.

Provision shall be made for padlocking the operating mechanism of disconnecting and earth switches in both open and closed positions.

Bearings shall be ball and roller type shall be protected from weather and dust by means of cover and grease retainers. Bearings pressures shall be kept low to ensure long life and ease of operation.

Each operated isolator shall be driven as well as manually operated and shall be complete with local selector switch and open / close push buttons. The function of all control facilitates operating isolators.

10.0 DESIGN, MATERIALS AND WORKMANSHIP

The live parts shall be designed to eliminate sharp points, edges and similar corona producing surfaces, where this is impracticable, adequate shields to be provided. All ferrous metal parts shall be hot dip galvanized, as per IS 2629. All metal parts shall be of such materials or treated in such a way so as to avoid rust, corrosion and deterioration due to continued exposure to atmosphere and rain. All current carrying parts shall be made from high conductivity electrolytic Copper.

Bolts, screws and pins shall be provided with standard locking device viz. Locknuts, spring washers, keys etc. and when used with current carrying parts, they shall be made of copper silicon or other high conductivity and wear resistant alloys.

The switches should not need lubrication of any parts except at very long interval of five year minimum.

11.0 PROTECTIVE COATINGS

All ferrous parts including bolts, nuts and washers of the switches assembly shall be galvanized to withstand at least six times one minute dips in Copper Sulphate solution of requisite strength (Pierce tests) except the threaded portions which should withstand four dips.

12.0 INSULATORS

Support insulators for all type of isolators shall be of solid core type. The insulator shall be made of homogeneous and vitreous porcelain of high mechanical and dielectric strength. It shall have sufficient mechanical strength to sustain electrical and mechanical loading on account of wind load, short circuit forces etc. Glazing of the porcelains shall be of uniform dark brown color with a smooth surface arranged to shed away rain water. The porcelain shall be free from laminations and other flaws or imperfections that might affect the mechanical or dielectric quality. It shall be thoroughly vitrified, tough and impervious to moisture. The porcelain and metal parts shall be assembled in such a manner and with such material that any thermal differential expansion between the metal and porcelain parts throughout the range of temperature specified in this specification shall not loosen the parts or create under internal stresses which may affect the mechanical or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stresses in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings. The insulator shall be suitable for water washing by rain or artificial means in service condition. Profile of the insulator shall also conform to IEC-815. Insulator shall have a minimum cantilever strength of 800 kgs. Caps to be provided on top of the insulator shall be of high grade cast iron or malleable steel casting. It shall be machine faced and hot dip galvanized. The cap shall have four numbers of tapped holes spaced on a pitch circle diameter of 76 mm. The holes shall be suitable for bolts with threads having anti corrosive protection. The effective depth of threads shall not be less than the nominal diameter of the bolt. The cap shall be so designed that it shall be free from visible corona and shall have radio interference level within 500 micro volts. Casing shall be free from blow holes cracks and such other defects.

13.0 CONTROL CABINET:

The control cabinet of the operating mechanism shall be made out of Aluminum sheet of minimum **3mm** thickness. Hinged door shall be provided with pad locking arrangement. Sloping rain hood shall be provided to cover all sides. 15 mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection of at least IP 55 as per IS 2147/IS-3947. The cabinet shall be suitable for mounting on support structure/or on a separate plinth foundation with adjustment for vertical, horizontal and longitudinal alignment. Details of these arrangements shall be furnished along with the offer.

14.0 Gear :

The Disconnecter / Isolator may be required to operate occasionally, with considerably long idle intervals. Special care shall be taken for selection of material for gear and lubrication of gears to meet this requirement. The gear shall be made out of Aluminum bronze or any other better material lubricated for life with graphite or better quality non-drawing and non-hardening type grease. Wherever necessary automatic relieving mechanism shall be provided suitable relay, Device shall be provided to prevent over loading of the motor. Single phase preventer (for 3 phase motor) shall be provided to operate on open circuiting of any phase and shall trip off the motor. Complete details of the devices shall be furnished in the offer.

15.0 Terminal block and Wirings –

Each operating mechanism shall be provided with 1100V grade stud type terminal block of polyamide material of **Elmex/Connectwell** make. All auxiliary switches, interlocks and other terminals shall be wired up to terminal block. The terminal block shall have at least 20% extra terminals. All wiring shall be carried out with 1.1KV grade insulated 2.5 sq mm copper wires.

A. Position indicator :

A position indicator to show the isolator is in ON or OFF position to be provided.

B. Name plate :

Isolator, earthing switches and their operating devices shall be provided with name plate. The name plate shall be weather proof and corrosion proof. It shall be mounted in such a position that it shall be visible in the position of normal service and installation.

It shall carry the following information's duly engraved or punched on it.

C. Isolator Base

Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage –
Rated normal current –
Rated short time current (rms) and duration –
Rated short time peak current (kA_{peak})
Weight

D. Earthing Switch

Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage –
Rated normal current –
Rated short time current (rms) and duration
Rated short time peak current (kA_{peak})
Weight

E. Operating Device

Name of manufacturer –
Order No.
Type Designation –
Reduction gear ratio –
AC motor
1) Rated auxiliary voltage
2) Starting current
3) Designation of AC motor as per I.S 4722/325
4) Starting torque at 80% of supply voltage
5) Over travel in degrees after cutting off supply

Total operating time in seconds

- 6) Close operation – Electrical
- 7) Open operation – Electrical
- 8) Open operation – Manual

All components shall be given adequate treatment of climate proofing as per IS:3202 so as to withstand corrosive and severe service conditions.

All metal parts not suitable for painting such as structural steel, pipes, rods, levers, linkages, nuts and bolts used in other than current path etc. shall be hot dip galvanized as per IS -2629.

Complete details of painting, galvanizing and climate proofing of the equipment shall be furnished in the offer.

16.0 TESTS

16.1 Type Tests

Isolators offered, shall be fully type tested as per the relevant standards. The Bidder shall furnish the first page valid type test reports for their different type of offered Isolators, duly signed, along with the offer.

- a) Short time withstand & peak withstand current test for Isolator & Earth Switch.

- b) Power frequency (Dry & Wet),Lightening Impulse dry withstand Test
- c) Mechanical endurance Test
- d) IP-55 test

During type tests the isolator shall be mounted on its own support structure or equivalent support structure and installed with its own operating mechanism to make the type tests representative. Drawing of equivalent support structure and mounting arrangements shall be furnished for Owner's approval before conducting the type tests.

The type tests shall be conducted on the isolator along with approved insulators and terminal connectors.

Mechanical endurance test shall be conducted on the main switch as well as earth switch of one isolator of each type

16.2 Acceptance and Routine Test :

All acceptance and routine test as stipulated in the relevant standards shall be carried out by the supplier in presence of Owner's representative.

Mechanical operation test (routine test) shall be conducted on isolator (main switch and earth switch) at the supplier's works as well as Owner's substation site.

Immediately after finalisation of the programme of type / acceptance, routine testing the supplier shall give sufficient advance intimation (clear 20 days advance intimation), along with shop routine test certificates, valid calibration reports from Govt. approved test house for the equipments, instruments to be used during testing for scrutiny by the Owner to enable him to depute his representative for witnessing the tests. If there will be any discrepancies in the shop routine test certificates and calibration reports furnished by the firm then after settlement of the discrepancies only, Owner's representative will be deputed for witnessing the tests.

Special tests proposed to be conducted (if decided to conduct) as type test on isolators, are given at TABLE-1 IN this chapter. These special type test charges shall be quoted along with all other type tests as per relevant IEC standard and these charges shall be included in the total bid price.

Test certificates of various items including but not limited to the following shall be furnished at the time of routine tests.

- i. Chemical analysis of copper along with a copy of excise certificate indicating genuine source of procurement of electrolytic grade copper.
- ii Bearings
- iii Fasteners
- iv Universal / swivel joint coupling

- v Insulators
- vi Gears
- vii Auxiliary switch
- viii Overload / single phase preventer relay
- ix Interlocking devices
- x Terminal block
- xi Any other item

17.0 INSPECTION: As per the GCC and Chapter E2 of the Technical specification

18.0 DOCUMENTATION

The Bidder shall the following drawings / documents within one month of LOA.

- a) General outline and assembly drawings of the dis-connector operating mechanism, structure, insulator and terminal connector.
- b) Sectional views and descriptive details of items such as moving blades, contacts, arms contact pressure, contact support bearing housing of bearings, balancing of heights, phase coupling pipes, base plate, operating shaft, guides, swivel joint operating mechanism and its components etc.
- c) Loading diagram
- d) Drawings with structure for the purpose of type tests.
- e) Name plate.
- f) Schematic drawing.
- g) Type test reports.
- h) Test reports, literature, pamphlets of the bought out items and raw material.

The contractor should submit two sets of final versions of all the above said drawings for Owner's approval. The Owner shall communicate his comments / approval on the drawings. The supplier shall, if necessary, modify the drawings and resubmit the modified drawings for Owner's approval within two weeks from the date of comments. After receipt of approval the supplier shall within three weeks submit 15 prints and two good qualities re-producible of the approved drawings for Owner's use. Six sets of the type test reports, duly signed by the Owner shall be submitted by the supplier for distribution, before commencement of supply Adequate copies of acceptance and routine test certificates, duly approved by the Owner shall accompany the despatched consignment.

The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the Owner. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier risk.

19.0 INSTRUCTION MANUALS :

Fifteen copies of the erection, operation and maintenance manuals in English be supplied for each type of disconnect one month prior to dispatch of the equipment. The manual shall be bound volumes and shall contain all drawings and information required for erection, operation and maintenance of the disconnect including but not limited to the following particulars.

- (a) Marked erection prints identifying the component parts of the disconnect or as shipped with assembly drawings.
- (b) Detailed dimensions and description of all auxiliaries.
- (c) Detailed views of the insulator stacks, metallic, operating mechanism, structure, interlocks, spare parts etc.

TABLE – I

LIST OF SPECIAL TESTS TO BE CARRIED OUT IF DECIDED BY THE OWNER

Sl. No.	Name of the Test	Standard to which it conforms.
1.	Test for visible Corona and Radio interference voltage (RIV) on disconnectors and terminal connector	NEMA Pub No. 107-1964 ISRI Pub No. 1-1972
2.	Tests on insulators	IS-2544 IEC. 168
3.	Tests on terminal connectors	IS:5561
4.	Tests on galvanised components	IS:2633
5.	Stalled torque test on motor operating mechanism	At 110% of supply voltage

CHAPTER – E5 - 8

TECHNICAL SPECIFICATION

FOR OUT DOOR

AB SWITCH

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OF
AB SWITCH

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TECHNICAL SPECIFICATION FOR AB SWITCH

1.0 SCOPE:-

This specification covers manufacturing testing and supply of 3 Pole, 200Amp, 50Hz, Single break for 33kV Air Break switches for outdoor installations to be used at 33/11 kV Sub-stations /Structures (Station Transformer).

The materials shall be procured from a vendor having three years of experience.

1.1 DESCRIPTION OF THE MATERIALS:-

The A.B. Switch sets shall conform to the following parameters:-

Sl. No.	Description	Parameters of AB Switch
		33kV
i)	Number of poles	3
ii)	Number of Post Insulator per pole	4 nos. (22/24 kV class)
iii)	Nominal system voltage	33kV
iv)	Highest System Voltage	36kV
v)	Rated frequency	50Hz
vi)	System earthing	Effectively earthed.
vii)	Rated nominal current Amp.	200Amp
viii)	Altitude of installation	Not exceeding 1000 M

The post insulators used in the A.B. Switches shall have the following ratings

Sl. No.	Description	Parameters P.I. of AB Switches for
		33kV
i)	Power frequency withstand voltage (dry) kV (rms)	70kV
ii)	Power frequency withstand voltage (wet) kV (rms)	95kV
iii)	Impulse withstand voltage (dry) kV (peak)	170kV
iv)	Power frequency puncture withstand voltage	1.3 times the actual dry flashover voltage of the unit

2.0 STANDARDS: - The AB Switch Set shall conform to the following standards:-

- i) IS-9920 (Part-I to V.)
- ii) IS-2544/1973 (for porcelain post insulators)
- iii) IS-2633 (for galvanization of ferrous parts.) or its latest amendments if any.

2.1 **INSULATORS:-**

25 KV class (for 33kV AB Switches) Post Insulators complete with pedestal cap duly cemented to be used in the AB Switch Set conforming to IS-2544/1973

The **Type test certificate** of the Post Insulators from their manufacturer for within one month of LOA.

The Bidder shall mention make, type of insulation materials, metal fittings, Creepage distance, protected Creepage distance, tensile strength, compression strength, torsion strength and cantilever strength.

2.2 **CLIMATIC CONDITIONS:-**

Please refer chapter -E3 of Technical Specification on climatic conditions.

3.0 **TECHNICAL DETAILS:-**

- 3.1 The 33kV A.B. Switch Set shall be gang operated (**with double tandem pipe**) single air break outdoor type horizontal mounting having 4 nos. 22/24 KV post insulator per phase. The operating mechanism shall be suitable for manual operation from the ground level and shall be so designed that all the three phases shall open or close simultaneously. The Switches shall be robust in construction, easy in operation and shall be protected against over travel or straining that might adversely affect any of its parts. The required base M.S. Channel, phase coupling rod, operating rod with intermediate guide braided with flexible electrolytic copper, tail piece of required current carrying capacity and operating mechanism with 'ON' & 'OFF' positions shall be provided. The operating rod shall be medium gauge of 32mm diameter nominal bore G.I. pipe single piece 6 meters. The phase coupling rod for gang operation shall medium gauge 25mm dia nominal bore G.I. Pipe. Rotating post insulators shall be provided with suitable bearing mounted on a base channel with 6 mm thick thrust collar and 6mm split pin made out of stainless steel. The operating down rod shall be coupled to the spindle (minimum dia - 32mm) for gang operation through another suitable bearing by two numbers 10mm dia through stainless steel bolts with double nuts. The post insulators should be fixed with the base channel using Galvanized Nuts and Bolts.

All the bearings shall be provided with grease nipple. All ferrous parts shall be galvanized and polished. The pipes shall be galvanized in accordance with IS-4736/1968.

3.2 **Mounting:-** The A.B. Switches shall be suitable for horizontal mounting in all type of sub-station structures.

3.3 **Switching Blades:-** It shall be made out of electrolytic copper with silver plated. The approximate size shall be 250mm x 50 x 8mm for 33kV. The switch shall have such a spring mechanism so as to ensure that the speed of the opening of contact is independent of speed of manual operation

3.4 **Fixed Contracts:-** The fixed jaw type female contracts (50x8x80)mm for 33kV shall be made of electrolytic copper (minimum 95 % copper composition) duly electroplated controlled by Phosphor bronze high pressure spring housed in robust G.I. Cover.

It is essential that provision shall be made in fixed female contracts to take the shock arising from the closing of moving contract blade without the same being transmitted to the post insulator. The arrangement made in this regard shall be specifically shown in the drawing.

3.5 **Arcing Horn-** As the switches are generally meant for isolating transmission line and distribution transformers, suitable arcing horns shall be provided for breaking the charging current horn shall be made of 10 mm dia G.I. Rod with spring assisted operation.

3.6 **Terminal Connectors:-** Terminal connectors shall be robust in design. The size of fixed connector shall be (80 x 50 x8 mm) and size of movable connector shall be of (80 x 50) x (80 x 50) x 8 mm of copper casting with uniform machine finishing duly silver plated made out of minimum 95 % copper composition with 2 nos. 14 mm dia holes provided with suitable brass bolts and double nuts, flat washers & 2 nos. bimetallic solderless sockets suitable up to ACSR Panther or AAA 232 mm² conductor.

3.7 **Spacing:-** The minimum clearance between phase to the switch shall be 1200 mm. The operating down rod shall be at a transverse distance of 300 mm from the outer limb of the switch. The centre spacing between two post insulators of the same phase shall be 560 mm. In the open position of the A.B. Switches the moving blade shall rotate through an angle of 90⁰. This shall be exhibited in the drawing.

3.8 **Drawing & Literatures:-** Drawings of each item 33 kV 200 Amp, 3 Pole, single break A.B. Switch shall be furnished along with the tender.

The details of construction and materials of different parts of the A.B. Switches shall clearly be indicated in the tender and illustrative pamphlet / literature for the same shall be submitted along with the tender.

4.0 TESTS & TEST CERTIFICATE

4.1 Type Test:- Certificates for the following type tests conducted within five years proceeding to the date of opening of tender on prototype set of A.B Switch in a Govt. Approved Testing Laboratory preferably at CPRI, Bhopal/ Bangalore shall have to be submitted for reference and scrutiny.

- i. Impulse voltage dry test
- ii. Power frequency voltage dry test
- iii. Power frequency voltage wet test
- iv. Temperature of resistance.
- v. Measurement of resistance.
- vi. Test to prove the capability of carrying the rated peak short circuit current and the rated short time current.
- vii. Mainly active load breaking capacity test.
- viii. Transformer off-load breaking test.
- ix. Line charging breaking capacity test.
- x. Operation tests.
- xi. Mechanical endurance test.
- xii. Mechanical strength test for the post insulator as per IS-2544/1973.
- xiii. Test for galvanization of metal (ferrous) parts as per IS-2633/1973.

Besides, mechanical endurance test will have to be conducted on one set in the presence of our authorized person who shall be deputed to carry out acceptance tests before delivery of the materials.

4.2 Routine Tests:- The following routine tests shall have to be conducted on each set and results are to be furnished for consideration of deputed inspecting officer for inspection and conducting testing of the materials.

1. Power frequency voltage dry test
2. Measurement of resistance of main circuit
3. Tests to prove satisfactory operation.
4. Dimension check
5. Galvanization test.

5.0 GUARANTEED TECHNICAL PARTICULARS:-

The tenderer shall furnish the guaranteed technical particulars duly filled in the format at **chapter E-24** along with the tender.

6.0 COMPLETENESS OF EQUIPMENT:-

Any fittings, accessories for apparatus which may not have been specifically mentioned in this specification but which are usual or necessary in equipment of similar plant shall be deemed to be included in the specification and shall be supplied by the Tenderer without extra charge. All plant and equipment shall be completed in all details whether such details are mentioned in the specification or not.

CHAPTER – E5 - 9

**TECHNICAL SPECIFICATION
FOR
SUB STATION STRUCTURE**

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OF
SUB STATION STRUCTURES

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Sub station Structures

1.0 Scope :

All the galvanized Substation Structures shall be provided by the Contractor.

2.0 Standards :

The steel materials shall comply with the requirements of latest issue of I.S :808 & I.S: 2062 for Gr – A except where specified otherwise.

3.0 Column Structure

The T₁ type H Pole structures are to be constructed with two parallel run 7.5 Meter meter long 150 x 76 x 6.5 mm G.I. Channels. Both the channels are separated by 150 mm distance (run through the entire length). The channels are further connected with 22 No. stiffeners (11 on each side) of size 100 x 270 x 5.7mm G.I. Flats welded to both the channels along 75 mm side (separated by 150 mm).

At the bottom the column is fixed with a BASE Plate (i) 620 x 620 x 12 mm galvanized & 6 Nos. of 33.5 mm dia holes for taking foundation bolts of size 32 mm dia 1400 mm long. On both sides of the channels (300 mm side) two nos. of stiffeners (ii) are welded with base plate and on 150 mm side two stiffeners (iii) are welded with base plate.

4.0 Beams / Girders:

The T2 Column shall be fabricated from galvanized 175 x 75 x 6mm channels as per the drawings / field requirements.

5.0 Dimensions and Properties

MC DESIGNATION	150 x 76 mm MC	175 x 75 mm MC
Weight kg/m "M"	17.7	19.6
Sectional Area (cm ²) "a"	22.6	24.9
Depth of Section (mm) "D"	150	175
Width of Flange (mm) "B"	76	75
Thickness of Flange (mm) "t"	6.5	6
Thickness of Web (mm) "T"	9.00	10.2
Corner Radius (mm) "R ₁ "	10.00	10.5

Moment of Inertia (cm ⁴)		
I _{xx}	813.00	1240
I _{yy}	110	122
Radius of Gyration (cm)		
R _{xx}	6.00	7.04
R _{yy}	2.20	2.21
Length in Meter		
"T ₁ " &"	7500 mm	7500 (33kV)
"T ₂ "	6000 mm	

* where MC refers to the classification of the channels as Indian Standard Medium Weight Channels.

- ◆ Holes should be provided for fixing the foundation bolts as specified above and as per the drawings for the above column structures.

6.0 Tests

- 6.1** All steel channels and other steel sections used in the manufacture of structures shall have been type tested with respect to their calculated working and ultimate tensile failure loads utilizing the mechanical properties as tabulated in this specification and IS –808 1964. This shall have been achieved as per the procedure in the Transverse Strength Test.

6.2 Transverse Strength Test for Steel Sections

The steel sections may be tested in either a horizontal or vertical position. If tested in the horizontal position, provisions shall be made to compensate for the overhanging weight of the column.

For this purpose the overhanging portion of the column shall be supported on a moveable trolley or similar device.

The pole shall be rigidly supported at the butt end for a distance equal to the designed depth of planting.

The working load on the column should correspond to those that are likely to come onto the column during its working life. The offered designs shall meet system requirements with the point of application of the working loads as per the Bidder's design but not more than 600 mm from the top of the

column.

The steel column shall be deemed to have passed the test if no permanent deformation is visible at the rigidly supported end and the permanent set at the point of load application does not exceed 13 mm.

The load shall then be reduced to zero and increased gradually to a load equal to the design working load plus 10% of the minimum ultimate transverse load, and held for 2 minutes. The procedure shall be repeated until the load reaches a value of 80% of the minimum ultimate transverse load and thereafter increased in increments of 5% until failure occurs.

Each time the load is applied, it shall be held for two minutes.

The column shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

The factor of safety (FOS) for steel section is 2.

7.0 Bolts and nuts

All bolts, studs, screw threads, bolt heads and nuts shall comply with the appropriate national standards for metric threads, or the technical equivalent.

All nuts and pins shall be adequately **locked**.

Head of the bolt in bolt and nut assembly in the horizontal plane must remain in the top. All bolts, nuts shall be treated to prevent corrosion, by hot dip galvanising and washers are to be electro galvanized.

Each bolt or stud shall project minimum three threads through its nut, except when otherwise approved for terminal board studs or relay stems.

8.0 Galvanising

8.1 General

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

8.2 Galvanising

All steel sections including nuts, bolts & washers shall be . hot dip galvanised.

9.0 Labels and plates

All columns shall be clearly labelled indicating, where necessary, its purpose and service positions. The material of all labels and the dimensions, legend, and method of printing / embossing shall be as per approval.

All labels and plates for outdoor use shall be of non corroding material. Where the use of enamelled iron plates is approved, the whole surface including the back and edges, shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.

Labels shall be engraved in English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.

Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya or English with the title and special instructions on it shall be provided.

No scratching, corrections or changes will be allowed on name plates.

CHAPTER- E5 -9

TECHNICAL SPECIFICATION FOR CT CONSOLE BOX AND BAY MARSHALLING KIOSK

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OF
CT CONSOLE BOX AND BMK

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TECHNICAL SPECIFICATION FOR CT CONSOLE BOX & BAY MARSHALLING KIOSK (OUTDOOR)

1.0 CT CONSOLE BOX

The Box should be made out of CRCA steel duly painted having 3mm thickness suitable for outdoor type & complying with IP: 55.

The details size of the Box is as follows:

Height = 900mm
Width = 450mm
Breadth = 300mm

The CT console box having facilities of door for opening.

There shall be 3 rows of disconnecting type terminal blocks of Elmex / Connect well make, each row shall have minimum 15nos TB (should continuously carry minimum 20A & dia of the stud 6mm) with end plates.

There shall be provision of earth strips inside the Box (25x3mm thickness, Copper strips).

On the top of the Box, Connopy to be provided for easy drainage of water.

2.0 BAY MARSHALLING KIOSK (BMK):

- 2.1. Same as ACDB but out door type. The purposes of these boards are to be installed in the switch yard at different locations. There shall be two incomer as source I and source II. There shall be adequate AC out lets both 3 phase with neutral and single phase, which will be taken to all the equipments and equipment marshalling boxes. At lest 20% extra outlets are to be provided besides the requirement to meet during exigencies. All the inlet and out lets shall be provided with MCB's. The board shall have two doors one at front and the other at the rear end. Since these boards are to be installed out side in the switch yard sufficient care as per the relevant standards are to be taken care fomr weathering effect. At the front end all AC inlets and out lets are to be provided and at the rear end terminal blocks are to be provided in column wise for DC control /AC control purpose. The minimum quantity of terminal blocks of rating 20 Amps shall be 300 nos with duly marked the number of terminals. At the front side also adequate capacity (current rating) as per the rating of MCB terminal blocks to be provided for inlet and out let points of AC supply.
- 2.2. Proper engineering to be made and to be submitted for approval to OPTCL before manufacturing and supply. The components and wirings to be used shall be of as per IS standard and of reputed make.

CHAPTER – E6

TECHNICAL SPECIFICATION

FOR

BATTERY & BATTERY CHARGER

TABLE OF CONTENTS OF BATTERY & BATTERY CHARGER

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PART – A

TECHNICAL SPECIFICATION

FOR

48V VRLA TYPE STORAGE BATTERY

TECHNICAL SPECIFICATION FOR 48V VRLA TYPE STORAGE BATTERY

1.0 SCOPE: Supply, installation and commissioning of 48V VRLA type storage Battery along with Battery charger. It shall have 4nos. of 12V battery & 100AH capacity. The materials offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

2.0 STANDARDS :

The equipment shall comply in all respects with the latest edition of relevant Indian Standard Specifications and IEC except for the modifications specified herein

3.0 INSTALLATIONS :

Batteries shall be installed at indoor

4.0 DETAILS OF SPECIFICATIONS OF VRLA Type (48V)

Battery:

The batteries shall be made of closed type lead acid cells with VRLA Type (48V) plates manufactured to conform to IS:15549 of 2005, IEC60896-21 & IEC60896-22 of 2004.

Capacity :

The capacity of the batteries shall be as follows :

- i) Voltage. - 48V
- ii) Output at 27⁰ C - 100AH at 10 hrs. discharge rate.

The batteries shall normally remain under 'floating' condition with the 'trickle' charger supplying the continuous load. However, the batteries shall be capable of supplying the following loads under emergency conditions without any assistance from the chargers and without their terminal voltage falling below 43V [90% of rated voltage].

Stage emergency - 15A for 3 hours for lighting.

The number of cells for 48V batteries shall be so chosen that for the nominal floating voltage of the cells, the battery voltage shall be 51.85V and for the minimum [discharged condition] voltage of the cells, the voltage of the battery shall not be less than 43.2V, while the assigned rating of the battery bank can not lowered below its rated voltage of 48V volts. It shall have 4nos. of 12V battery & 100AH capacity.

5.0 DESIGN AND CONSTRUCTIONAL DETAILS:

5.1 Plates :

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free,

long life both in cyclic as well as in float applications.

Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life, durability and trouble free operation of battery.

PLC (programmable logic control) operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of paste preparation is not allowed.

5.2 CONTAINER AND LID :

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability.

5.3 Separators :

The separators shall be of synthetic material conforming to the latest edition of IS-6071-1986. These shall permit free flow of electrolyte and would not be affected by the chemical reaction inside the cell and shall last for indefinite time. The internal resistance factor of the separators shall assure high discharge characteristics under all operating conditions. Proper arrangement to keep end plates in position shall be furnished by the bidder along with his offer.

5.4 Electrolyte :

The electrolyte shall be prepared from the battery grade Sulphuric acid conforming to IS-266-1993 and shall have a specific gravity of 1.2 at 27°C. The Sulphuric acid of battery grade shall be colorless liquid. The concentrated Sulphuric acid on dilution with an equal volume of distilled water shall be free from suspended matter and other visible impurities. The Sulphuric acid shall meet the requirements of columns – 4 and 5 Table –1 of IS-266-1993. VRLA battery does not require any electrolyte top up.

5.5 Plate group bar with terminals :

The plate group bar with terminals shall conform to IS-1652-1991. The positive and negative terminals shall be clearly marked for easy identification. The legs of the plates of like polarity shall be connected to the load, turned to a horizontal group bar having an upstanding terminal post adopted for connection to the external circuit. The group bars shall be sufficiently strong to hold the plates in position.

5.6 Buffers/spring:

Suitable buffers / springs shall be provided in the cells to keep the end plates in position. These shall have adequate length and strength.

5.7 Cell lids :

Lids used with sealed or closed type cells shall be of glass, plastic or ebonite and shall be provided with vent plugs. Terminal post shall be suitably sealed at the lid to prevent escape of acid spray, by means of rubber grommets, sealing compound or other suitable device. The positive and negative terminal posts shall be clearly and indelibly marked for easy identification.

5.8 Water :-

Water used for preparation of electrolyte and also to bring the level of electrolyte to approximately correct height during operation / testing shall conform to relevant standards.

5.9 Venting device :

The venting device shall be anti splash type and shall allow gases to escape freely but shall effectively prevent acid particles or spray from coming out. There shall be two vent holes, one serving as a guide for acid level indicator for checking the electrolyte level and other to permit drawing of electrolyte samples, servicing, checking of specific gravity etc.

5.10 Marking :

Acid level line shall be permanently and indelibly marked around on all the containers.

The following information shall be indelibly marked on the outside surface of each cell :

- [i] Manufacturer's name, type and trade mark.
- [ii] Nominal voltage.
- [iii] AH capacity at 10 hours rate with specified end cell voltage.
- [iv] Cell number.
- [v] Upper and lower electrolyte level in case of transparent containers.
- [vi] Type of positive plate.
- [vii] Type of container.
- [viii] Date of manufacture [month and year] or [week and year].

5.12 CONNECTORS:

Bars tinned copper lead connectors shall be employed for Inter-cell and inter-row, inter-tier connections. However, the tee-off connection from the battery unit shall be made with acid resisting cables of suitable size. A suitable terminal box along with acid-resisting cable shall be provided by the Contractor for this purpose. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and shall be provided with corrosion resisting lead coating. The connectors shall be of sufficient cross-section to withstand all the working conditions including one minute discharge rate as well as short circuit conditions.

- [a] Lead coated connection hardware such as bolts, nuts etc. 5% extra, or any other connector suitable for VRLA type Battery.
- [b] Ampere-hour Meter [10 hour discharge rate] of 100 –120 AH range-1 no.
- [c] Any other accessories, not specified but required for installation, satisfactory operation and maintenance of batteries for a period of 5 [five] years.

6.0 MAXIMUM SHORT CIRCUIT CURRENT :

The Bidder shall state the maximum short circuit current of each battery along with the safe duration in seconds which it can withstand. Methods, proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

7.0 CHARGING :

The bidders shall state whether an equalizing charge is recommended for the battery. If so, the equalizing charge voltage, current, duration and the interval between the equalizing charging shall be specified in the Data sheet. Bidder shall also indicate the requirements for boost charging.

8.0 LIFE :

The minimum guaranteed life span of the battery should not less than 5 years. The bidder shall quote in his offer the guaranteed life of the battery when operating under the conditions specified.

9.0 INSTRUCTION MANUALS :

Fifteen sets of instruction manuals for installation, commissioning, charging and maintenance instruction shall have to be furnished.

10.0 TESTS:

10.1 TYPE TESTS :

The bidder shall submit the Type **Test reports** along with the drawing for approval for the following type tests, conducted as per relevant IS & IEC within five years from the date of opening of the bid from any Govt. approved laboratory and test witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

- [a] Verification of constructional requirements.
- [b] Verification of dimensions.
- [c] Test for capacity.
- [d] Test for retention of charge.
- [e] Endurance Test.
- [f] Ampere-hour and watt-hour efficiency test.
- [g] Test for voltage during discharge.

If the **Type Test report** [s] does/do not meet the requirements as per this specification, OPTCL at its discretion may ask the Contractor to conduct the above type tests [s] at the Contractor's cost in the presence of OPTCL's representative without any financial liability to OPTCL.

10.2 ACCEPTANCE TESTS :

Following shall constitute the acceptance tests which shall be test witnessed by the Owner's representative at the works of the manufacturer at the cost of supplier.

- [i] Verification of marking.

- [ii] Verification of dimensions.
 - [iii] Test for capacity for 10 hours discharge rate along with the Test for voltage during discharge.
 - [iv] Ampere-hour and watt-hour efficiency test.
- 10.3 The Owner may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.
- 10.4 The Contractor shall arrange for all necessary equipments including the variable resistor, tools, tackles and instruments. If a battery fails to meet the guaranteed requirement, OPTCL shall have the option of asking the Contractor to replace the same within 15 [fifteen] days from the date of declaring the same to be insufficient/failed / not as per the specification [s].

11.0 DRAWINGS / DOCUMENTS :

The tenderer shall submit the following drawings / documents within one month of placement of LOA.

- [a] General battery arrangement, proposed size of individual and over all dimensions along with sectional views showing all connections etc.
- [b] Pamphlets and technical literature giving detailed information of the batteries offered.

The Contractor shall submit the following drawings / documents in two copies for approval. :-

- [a] Lay out details of the batteries.
- [b] OGA and cross-sectional details for battery cells.
- [c] Instruction manuals for initial charging and subsequent charging.
- [d] Technical data, curves etc.

12.0 GUARANTEED TECHNICAL PARTICULARS :

The Guaranteed Technical Particulars, as called for in the chapter-E24 shall be furnished along with the drawing for approval.

13.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

PART – B

CHARGER FOR 48 V,100AH VRLA BATTERIES

CHARGER FOR 48 V,100AH VRLA BATTERIES

(15Amp single phase Charger (Float Cum Boost Charger) suitable for 48V, 100 AH, Maintenance Battery Type VRLA.

1.0 BRIEF DESCRIPTION

Charging equipment comprising of a **Float cum Boost (15 Amp for Float & 20Amp for Boost Charger) suitable for 48V DC, 100 AH, Maintenance free VRLA Battery** charger, is required to meet the D.C. power requirement of the sub-station under normal conditions, i.e., when AC auxiliary power supply is available and also to keep all the cells in the state of full charge. The float charger shall supply the continuous DC load at the bus bars in addition to keeping, batteries floated in a healthy condition. In case of failure of A.C. mains or sudden requirement of additional DC power, the battery shall meet the demand as the battery shall be connected in parallel with the charger. After the battery has discharged to a considerable extent, it shall be fully recharged by the 'boost' charger unit in a short period so as to prepare it for the next emergency. Even during the 'boost' charging of the battery, the continuous DC load at the bus shall be met by the trickle-charging unit. The 'boost' charging unit shall however be provided with suitable control arrangement to function as a stand-by for float charging unit in case of necessity. Input to Charger shall be 220V AC supply.

2.0 ARRANGEMENTS :

2.1 Trickle (Float) Charger :

- (a) The trickle charger shall have arrangement for regulation of D.C. output voltage by:-
 - (a) automatic voltage regulation system.
 - (b) Shall be of thyristor control type with both 'auto/manual' control arrangement.

2.2 Quick (Boost) Charger :

The quick charger shall be similar type as trickle charging equipment, but shall have the following features.

- (i) Shall be provided with control arrangement for 'auto/manual' current regulation features, necessary for quick charging
- (ii) Shall also have 'auto/manual' voltage control arrangement for use when the charger will be utilised as a trickle charger.

- 2.3** The 'Trickle' and 'Quick' charger shall be self supporting cubicle type with front panels hinged and suitable for mounting instruments, incoming A.C (3-ph) circuit breaker with thermal and instantaneous releases relays, contactors and control switches etc. The panels shall have access from the backside also.

These cubicles shall also house transformers, rectifiers and other equipment's, accessories, as stipulated in this specification.

3.0 DESIGN AND CONSTRUCTION DETAILS:

- 3.1 The 'trickle' charger and 'quick' charger shall be complete with silicon controlled rectifier units, dry type air-cooled transformers, control electronics, smoothing filters etc. suitable for operation from 220V \pm 10%, 50 Hz (-5%, +3%), 1-ph A.C. supply. The charger output shall be stabilized to \pm 1% of set value for \pm 10% input voltage variations and 0-100% load variation.
- 3.2 The battery charger shall have full-wave, Half-controlled thyristor controlled bridge rectifier circuit. The charger output voltage shall suit the battery offered. The float voltage shall be adjustable from 80% to 115% of nominal voltage. The boost voltage shall be adjustable from 80% to 135% of nominal voltage. Ripple voltage shall be less than 3% RMS voltage.
- 3.3 Each float charger shall be capable of floating each cell of the battery bank at the specified voltage and supplying specified float current continuously under normal system operation.
- 3.4 Under normal operation, the float charger shall be supplying the DC load current and at the same time trickle charge the station battery. When the battery voltage goes down considerably, automatic transfer arrangement shall be provided such that the battery is disconnected from the float charger and gets connected to the Boost charger. However, when battery is on boost charge, DC load shall be fed from the float charger. In addition, means shall be provided to ensure interruption free availability of control power from the battery whenever there is a power failure irrespective of whether the battery is on boost charge or float charge.
- 3.5 The selection of electronic components shall be used on ambient temperature of 50⁰C. and shall be of worst-case design to ensure continuous and trouble free service. The control electronics shall be built on plug in type glass epoxy printed circuit boards of modular design.
- 3.6 The maximum temperature, attained by any part of trickle charger and quick charger, when in service at site under continuous full load conditions shall not exceed the permissible limits as fixed by relevant standards and as corrected to site condition.

4.0 Charger Panel :

- 4.1 Charger Panels shall be rigid, self supporting structures, completely assembled and totally enclosed cubicle type construction, made out of structural steel members with sheet steel-coverings.
- 4.2 The enclosure of the charger shall be made of CRCA sheet steel of thickness not less than 3 mm for load bearing members, 2 mm for door and non-load bearing members and 3 mm for gland plates. Panels shall be offered with

base frame of 3.0 mm thick CRCA sheet, painted black all around, suitable for bolting/ welding/ grouting on to the foundation. Gaskets on doors and inter panel gaskets shall be of neoprene rubber.

- 4.3 The panel shall have hinged front and back doors with concealed type hinged locks and latches.
- 4.4 The panel shall have adequate cross –ventilation arrangement to avoid any undue rise in temperature.
- 4.5 All equipment's and wiring used in the panel shall be tropicalised dust proof and vermin-proof.
- 4.6 Power wiring for the chargers shall be done with 1.1KV grade, heavy duty, single core, stranded copper conductor PVC insulated cables or suitable sized PVC sleeved copper bus bars. Control wiring for the charger shall be done with 1.1 KV grade PVC insulated copper wires of cross section 2.5 sq. mm for all control connection. Wire of 2.5 sq. mm cross section shall be used for control bus. All control wiring shall be ferruled.
- 4.7 Necessary terminals for grounding the panel with two separate earthings shall be arranged for bottom entry and suitable cable glands shall be provided for the cables.
- 4.8 Each charger panel shall incorporate all the necessary controls, Indications, interlocks, protective devices and timing features to ensure any operation.

Provision shall be made with necessary contact / relays for annunciation in the event of alternating current power failures to the charger and automatic shut down of the charger by over-voltage / current devices. Annunciation shall however be prevented when the charger is manually shutdown or when A.C. power supply is momentarily interrupted for adjustable period of 1 to 5 seconds.

- 4.9 The float and equaliser charging rates shall both be adjustable from the front of the charger control panel. Each charger shall be protected against any damage from over voltage/ load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device for abnormal conditions of low battery voltage down to 38.4V (80%) of the rated voltage). But the chargers shall be disconnected from A.C. input supply through an over-voltage relay, if the input voltage exceeds 10% of the rated voltage of the equipment. Necessary selector switches for 'Trickle Charging' and 'Quick charging' shall be provided. There shall be 'make before break' type blocking Diodes and other equipments to be shown in the drawing or otherwise found necessary for charging or otherwise found necessary for charging the battery without increasing the voltage beyond safe value across the load shall also be supplied by the tenderer.

- 4.10 The rectifier units of the chargers shall be capable of supplying an impulse load of 6/7 times its rated capacity. The trickle charger in conjunction with automatic voltage regulators shall have drooping characteristics, So as to transfer the load beyond its capacity to the battery.
- 4.11 The incoming and outgoing circuits shall be provided with MCCBs with static releases for overload, short circuit and earth fault protections. The incoming power supply to the chargers will be from two sources with a facility of changeover switch. The change over facility shall be provided in the charger itself.
- 4.12 The battery circuit shall be provided with HRC fuse protection over a suitably rated load break isolator switch and reverse protection circuits.
- 4.13 Input volt meter and ammeter shall be of digital type and shall be 96 x 96 mm. Square. These meters shall be of accuracy class not less than 1.0 and shall be of flush mounting type with required PTs and CTs and selector switches. Output voltmeter shall be digital and ammeter shall be moving iron type and shall be 96 x 96 mm square. These meters shall be of accuracy class not less than 1.0 and shall be flush mounting type. The ammeter shall be centre zero type for measurement of charging and discharging current from the battery.
- 4.14 Cluster LED lamps for indicating 'Input on' condition and 'Output on' condition, float status on / off, boost status on / off etc. shall be provided. Annunciation with audiovisual alarms shall be provided for the following.
- a) Input mains failure.
 - b) Input phase failure.
 - c) Input fuse failure.
 - d) Rectifier fuse failure.
 - e) Filter fuse failure
 - f) DC over voltage
 - g) DC under voltage
 - h) Output fuse failure
 - i) Charger over-load
 - j) Earth leakage
 - k) Alarm supply fuse failure
 - l) Charger trip
 - m) Output MCCB tripped
 - n) AC under voltage
 - o) Battery low condition

ACCEPT, TEST AND RESET push buttons shall be provided. 20% spare annunciation windows shall be provided.

- 4.15 Any other item(s), not stipulated in this specification, but required for installation, operation and maintenance of the battery charger is / are included in the scope of supply without any extra charge to OPTCL.

5.0 TESTS

5.1 **Type Tests** : The bidder shall submit the Type **Test reports** along with the drawing for approval for the following type tests conducted on float cum boost charger as per relevant IS and IEC within five years from the date of opening of the bid and test-witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

- 1) Measurement of voltage regulation / AVR regulation
- 2) Efficiency and power factor measurement test
- 3) Temperature rises test so as to determine the temperature rise of SCR, Transformer primary, Secondary and core, Diode, capacitor, choke and cabinet etc.
- 4) Measurement of insulation resistance.
 - (i) AC input to earth.
 - (ii) AC input to DC output.
 - (iii) DC output to earth
 - (iv) Test for rectifier transformer.
 - (v) DC voltage current characteristic
 - (vi) High Voltage Tests.
 - (vii) Determination of regulation
 - (viii) Measurement of ripple
 - (ix) Reverse leakage test.

5.2 **Acceptance Tests** :

Followings shall constitute the Acceptance tests which shall be tested by the Owner's representative at the works of the manufacturer at the cost of the supplier (both for FC cum BC) for each charger. No sampling is allowed.

1. Measurement of voltage regulation / AVR Regulation
2. Efficiency and power factor measurement
3. Temperature rise test so as to determine the temperature rise of SCR, Transformer primary, secondary and core, diode, capacitor, choke and cabinet etc.
4. Measurement of insulation resistance.
 - 2 AC input to earth
 - 3 AC input to DC output
 - 4 DC output to earth
5. Test for rectifier transformer (all relevant tests as per corresponding ISS)
6. DC voltage current characteristic
7. High voltage tests.
8. Determination of regulation.
9. Measurement of ripple
10. Tests for indications and alarms as per this specification
11. Tests for indicating instruments.
12. Determination of system set points.
13. Soft start test

N.B. : The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the

temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipment's are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates, vendor's test certificates for different equipment's, accessories, instruments etc. shall be submitted, whenever required by the Owner.

6.0 DRAWINGS / DOCUMENTS

The tenderer shall submit the following drawings / documents for approval.

- I. OGA of the battery chargers
- II. General layout with overall dimensions
- III. Electrical schematic diagram showing connections and controls.
- IV. Leaflets and technical literature giving detailed information of the panels offered.

The contractor shall submit the following drawings / documents in 7 (seven) copies within 15 (fifteen) days from the date of issue of the purchase order for Owner's approval.

- a. OGA of the battery chargers.
- b. General layout with overall dimensions marked alongwith sectional views showing cable entry position etc.
- c. Rating calculations for transformer, rectifiers, diode, capacitor, inductor etc.
- d. Detailed schematic and connection and control wiring diagram for all the equipments.
- e. Complete bill of materials.
- f. Technical excerpts on operation.
- g. The circuit diagram of charger including circuit diagrams of all cards to facilitate the maintenance of chargers.

7.0 GUARANTEED TECHNICAL PARTICULARS

The Guaranteed Technical Particulars of this specification shall be furnished along with the tender. Any tender, lacking complete information in this respect is likely to be rejected.

The GTP for Battery charger shall be as chapter-E24 .

8.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed in the technical deviation sheet, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

N.B.: -Besides the above general technical requirements, all other stipulations, as enumerated in this technical specification shall be followed. Any deviation should be clearly brought out with clear explanation.

Any extra feature/ equipment / instrument as necessary for operation and performance of the battery charger for the 48V battery set as per this specification shall be provided without any extra cost to OPTCL.

CHAPTER - E7

TECHNICAL SPECIFICATION

FOR

AC DISTRUBUTION BOARD

AND

DC DISTRIBUTION BOARD

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OF
AC & DC DISTRIBUTION BOARDS

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TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARDS

1.0 General

Requirements of AC and DC systems.

The electrical auxiliary systems shall be of a quality commensurate with the performance, reliability and availability requirements of the substation.

The electrical station services shall be in accordance with all the relevant standards, shall satisfy the requirements specified herein and shall be designed to operate in the environmental conditions specified in the relevant sections of this Specification.

The electrical station systems shall be required to provide the voltage classes indicated in Table 1.1. for operation of various plant equipment operating mechanisms, plants, control and communication systems

Nominal Voltage V	Tolerance	Frequency Hz or DC	Phases	Wires	Neutral Connection
430	±10%	50(-5%,+3%)	3	4	Solidly earthed
240	±10%	50(-5%,+3%)	1	2	Solidly earthed
48	±10%	DC	DC	2	ungrounded

Table 1.1.Voltage classes

The auxiliaries shall be capable of withstanding all over frequency and undervoltage conditions without loss of supply to the power circuits or shutdown of any auxiliary system meeting the essential loads of the substation plant and equipment.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

1.1 Configuration

The basic design of the substation electrical auxiliary services shall be as shown in the schematic drawing. This drawing is for guidance only and the Contractor may propose an alternative keeping in view the design philosophy stipulated in this section of the Specification. The design philosophy for auxiliary supply systems shall be as follows:

The AC supply for station auxiliary systems shall generally be obtained from 33kV bus available at the substation site. The capacity of the station transformer is 100 KVA 33/0.43 KV shall be installed to provide reliable auxiliary power supplies.

1.2 Essential loads

These are loads whose failure will affect the capability of the station and station plant and equipment. These loads shall include station services of the Substation like supply to CB control cubicles, relay panels, Battery charger, illumination, air conditioning system etc.

1.3 Emergency loads

These are loads that must remain in service during complete loss of the ac power supply. These loads shall include the station battery chargers, disconnecting switch and circuit breaker operating mechanisms and the emergency lighting of the switchyard and control building. Some emergency loads operate on ac voltage and the others on dc voltage.

1.4 Normal loads

These loads, whose failure do not affect capability, shall include but not be limited to control building and switchyard lighting, control building air-conditioning, water pumps, oil treatment loads, etc.

2.0 415V AC distribution system

The incoming and outgoing feeder requirements have been provided in the specification. The details of ACDB & DCDB is furnished in clause-15.

2.1 General

The 430V secondary distribution system shall comprise 430V power centres serving the different classes of loads.

Each power centre shall consist of one station service transformer of 100 KVA capacity. The section of the 430V power centre shall be designed to carry the total load of the sub-station.

Restoration of normal supply conditions shall automatically return the power centre to the normal operating mode. The 430V power centres shall be of the metal enclosed switchgear type according to the relevant IEC or Indian Standards.

2.2 AC distribution board

The ACDB's shall be in accordance with the relevant IEC or Indian Standards and shall also comply with the following requirements:

The ACDB shall be located inside the control room at a suitable place.

2.3 Supply of essential loads

Essential loads shall be fed from ACDB so as to meet the complete requirement of the essential loads of the Substations.

2.4 Supply of emergency loads:

Only control room building shall have provision of emergency illumination fed from the DC system. The DC system is of 48 V.

2.5 Supply of normal loads:

Normal loads shall be fed from the ACDB & lighting distribution boards.

3.0 LVAC supplies and equipment

3.0.1 General

Switchboards shall be of the free standing design, suitable for mounting directly above the cable trenches laid inside the control room. Cable trench walls shall be flush with the control room floor. Switchboards shall be suitable for terminating all incoming and outgoing cables and will normally be of the bottom rear entry type, generally in accordance with IEC 947 and 439 and of metal clad design arranged for drawout isolation. Switchboards shall be equipped with moulded case & miniature circuit breakers. The use of fuse switches will not be permitted.

3.1 LVAC scheme

3.1.0 General Requirement

The 415V incoming supply shall be derived from the station auxiliary transformer. The incoming and outgoing feeder requirements have been provided in the specification. The details of ACDB & DCDB is furnished in clause-15 of this TS.

3.1.1 Main Distribution Board

The main distribution board shall be supplied from station auxiliary transformer. The board shall feed the following panels:

- Outdoor Lighting distribution board
- Indoor Lighting distribution board
- Air conditioning system
- Maintenance equipment and Oil treatment plant supplies.
- Battery Charger
- Breaker cubicles 33 KV side
- Breaker cubicles 11 KV side
- Relay panels 33 KV side
- Relay panels 11 KV side
- Water pump system
- Spare feeder for future use

3.1.2 Main lighting distribution board (indoor & outdoor)

The main lighting distribution board shall receive incoming supplies from the main distribution board. This board shall be further connected to lighting distribution panel. The incoming and outgoing feeder requirements have been provided in the specification. The details of ACDB & DCDB is furnished in clause-15 of this TS.

4.0 CONSTRUCTION

4.1 Panels

Engineer to give details as to the type of scheme required e.g. duplicate feeds with automatic changeover facilities etc or details of existing scheme where extensions to this are to be provided and where necessary detailing the number of spare ways etc.

For indoor applications the switchboards shall be of the cubicle pattern, each circuit being self-contained within its own cubicle (compartmentalized type). An access door shall be provided for each cubicle such that access can only be

obtained to individual circuits. Circuits shall be segregated one from the other by earthed metal. For outdoor installation they shall be of multi-box construction. Sheet steel for fabrication of the panels shall be a minimum of 3 mm thick for load bearing including gland plate & all other shall be 2.5 mm thick. All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

4.2 Switchboard

Switchboards shall be vermin proof and suitable for use in a tropical climate. All ventilating louvers shall be covered with a fine mesh from inside. All switchboards shall be provided with a degree of protection of IP 52 as per IEC 947 or equivalent Indian standard. Provision shall be made in all compartments for providing IP 52 degree of protection, when circuit breaker or module trolley, has been removed. Switchboards shall be of uniform height and shall not exceeding 2450mm. Switchboards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers. All switchboards shall be divided into distinct vertical sections, each comprising:

- i) A completely enclosed busbar compartment for horizontal and vertical busbars. Busbar chamber shall be completely enclosed with metallic partitions. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance. Access shall be possible without disturbing feeder compartment.
- ii) Completely enclosed switchgear compartment(s), one for each circuit for housing circuit breaker or motor starter.
- iii) A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with busbar chamber.
- iv) A compartment for relays and other control devices associated with a circuit breaker.

All access doors shall be provided with facilities for locking in the closed position. It shall be possible to move each circuit breaker or MCCB to the disconnected position without the need to open the cubicle access door. Attempted disconnection of a circuit breaker or MCCB when in the closed position shall not result in tripping of the particular equipment.

4.3 Cubicle

Cubicles may be arranged vertically in tiers, the number being limited only by the need to ensure that circuits are thermally independent. It shall be possible to work within each cubicle with the equipment withdrawn whilst the incoming contacts are energised. The minimum requirements for protection shall be:

- Insulating barriers installed between phases within the cubicle.
- An insulating cover to be affixed over the protruding feeder and busbar connections when the equipment is withdrawn.

Where this is not available, protection shall be provided by automatically operated shutters. It shall be possible to open the shutters intentionally, against spring pressure for testing purpose.

Each phase of the down dropper connections from the busbars to the equipment isolating contacts shall be separated from the incoming or outgoing connections and from the other phases by barriers. Cubicles shall be suitable for terminating all necessary cabling whether of copper or aluminium conductor design. It shall be possible to terminate any cable whilst adjacent circuits are energised.

4.4 Busbar and other equipment housing

All incoming connections, busbars and feeder connections up to the particular MCCB shall be capable of the short time current rating specified, but connections beyond the MCCB need only be matched to the MCCB characteristic. The overall height of each tier of cubicles shall be such that the operating handles of all equipment are within the reach of a person standing at ground level. Control switches as specified shall be fitted and suitably labelled to indicate their function. The equipment shall be complete with cable boxes and glands suitable for XLPE or PVC insulated cables. The switchboard shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

All equipment associated with a single circuit shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. The front of the compartment shall be provided with a hinged single leaf door complete with locking facilities. The main switch shall be operable from outside and will be interlocked with the compartment door such that the latter can be opened only when the switch is off. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. The main switch shall have the facility of being pad-locked in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch.

After isolation of power and control circuit connections it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable termination located in cable alley.

The temperature rise of horizontal and vertical busbars when carrying rated current along its full run shall in no case exceed 55 °C, with silver plated joints and 40 °C with all other type of joints over an outside ambient temperature of 50 °C.

All single front switchboards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.

All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carry out modifications.

The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley

may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to approval of the Project Manager.

All sheet metalwork shall be painted in accordance with the painting clause specified elsewhere in this Specification. The shade of the paint shall be 692 as per IS 5 (smoke grey).

5.0. STANDARDS

The equipment covered by this specification shall unless otherwise specified be built to conform to Indian Electricity Rule 2956 wherever applicable and shall satisfy the requirements of the latest Indian Standard. Permissible temperature rise shall be as per relevant ISS.

5.1 SWITCH BOARD DESIGN

The switch board shall be self supporting, steel cubicle, compartmentalized, fully enclosed with doors for access to the interior. The switch boards shall comprise a non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear 3 mm sheet shall be used for fabrication of the panels. Modular type construction for inter-changeability will be preferred.

The complete panels shall not be more than 2450 mm. high with the channel base and 500 mm. depth measured from rear to front faces and of suitable width. The working height shall be limited to maximum 2200 mm. The design shall be such as to permit extension at site on either end. The bottom of the switch board frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plates shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboard shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and holes shall be covered with fine wire mesh from inside (for indoor use). All control and power cables will be laid in open distribution trenches running under the A.C. switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates grouting bolts, lock nuts, washer, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhesive matter or greases. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing allowed by application of an undercoat to serve as base and binder for the finishing coat. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel or dark battle ship grey, evenly sprayed to present a fine appearance while the interior faces shall be sprayed with a finishing coat of

light grey paint to provide contrasting background for the wiring inside the cubicle. The internal illumination for working should be of adequate intensity CFL lamps.

A small quantity of finishing paint shall be supplied with the consignment of the Switchboards to enable the employer to restore at site any surface finish which may get damaged during transit.

5.2 BUS BARS

The bus bars shall be of E.G. copper/aluminum alloy, liberally sized for the specific current ratings (both short circuit and continuous currents). The size of the bus bars shall be such that the current density is not more than 1A/1.75 A per sq.mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying various phases of bus bars. Bus support shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creepage surface. Buses shall be spaced with adequate clearance between phases and phases to ground.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/riser from or to the bus bars should not be twisted but reasonable bend or joint may be allowed. The bidder shall submit necessary calculations about the adequacy of selected bus support insulator cantilever strength w.r to short circuit forces.

5.3 Earthing

Earthing of current free metallic parts on the body of the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm² and the main earth bar for the switchboard shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

5.4 Clearances and insulation level

Clearances and creepage distances in air shall be those stated in IEC 158 and 947 and be such that the equipment can withstand the dielectric tests specified.

5.5 Thermal performance of switchboard and equipment

The complete switchboard shall be capable of carrying rated load current without the temperature rise of any portion exceeding a level of 65°C. Parts that may be touched by operating personnel shall not exceed a level of 35°C. In determining the load current performance of tiered cubicles it shall be assumed that all circuits are carrying rated current.

The cross sectional area of the busbars may be graded according to the current rating, but shall remain capable of the short time current rating stated in the Schedules.

5.6 Protection Co-ordination

It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the MCCB with the upstream and downstream to provide satisfactory discrimination.

6.0 EQUIPMENT TO BE FURNISHED

6.1 General

The Contractor shall supply all equipment in accordance with this Specification in each of the modules as specified in the following sub clauses.

6.2 Type Designation /Description of Modules

Each 415V switchgear and distribution board shall comprise of a number of different type of modules as detailed in the following clauses :

415V switchgear modules and applications:

ACDB:

- | | | |
|-----|---|---|
| 1. | 415V, 250A, P2 duty 20 kA, 50 Hz MCCB having 4 NO and 4 NC Aux. contacts. | 1 |
| 2. | Auxiliary relays | 1 |
| 3. | Indicating lamps with resistors and coloured lenses suitable for 240V AC. | 3 |
| | With over load & over current & earth fault protection. | |
| (a) | HRC Fuses mounted on the above chassis. | 6 |
| (b) | Four position voltmeter selector switch. | 1 |
| (c) | Voltmeter (0-500V) | 1 |
| (d) | Under voltage protection | 1 |
| (e) | Indicating lamps with series resistor and colour lenses (Red, blue and yellow). | 3 |

6.3 INDICATING LAMPS

Indicating lamps shall be LED type provided with suitable safety resistor, and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover. The lamp holders shall preferably be screwed type.

6.4 SPACE HEATERS

The A.C. switchboards shall be provided with space heaters rated for 240 volts single phase A.C. Each heater shall be provided with ON/OFF switch. The wattage of the heater shall be such as to keep 10 deg. C. above the ambient

temperature during rainy season but the temperature shall not damage the wiring.

6.5 CABLE TERMINATION

Switchboards shall be designed to facilitate PVC cable entry from the bottom of the switchboards. Removal plates shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection.

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029" copper conductor for control and Aluminum for cables feeder up to 15 Amp. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with terminating the internal wiring and outgoing cables.

Power terminals shall be complete with lugs and control terminals shall be clamp type. Screw type terminals with screw directly impinging on conductor shall not be supplied.

Each terminal for 15 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029" copper wires at one end without any damage to the connector or any looseness of connection.

The terminal shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality. Terminal block connector built from cells of moulded dielectric and brass-stud inserts shall be provided. The connection stud shall project at least 6 mm. from the lock nut surface. All blocks shall be shrouded of easily removable shrouds moulded of transparent dielectric material of non-breakable type.

6.6 WIRING

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and inter-locking schemes.

All wiring shall be complete up to the terminal blocks at the factory.

Control wiring shall be carried out with flexible, heat resistant, switchboard wires. PVC insulated with 2.5 sq.mm. stranded copper conductors. Each wire shall be identified at both ends with wire destinations numbered ferrules in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points. Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminal, blocks, meters, relays, instruments, and other devices used in the switchboards. Red, Yellow, Blue and Black ferrules shall be used for Red, Yellow, Blue phases and Neutral respectively.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination.

All spare contacts of the equipment shall be wired up to the terminal block. The wiring shall be of 1.1 KV grade. At least 20% spare terminals shall be provided.

- Terminal connection shall be such that the conductors, LM10 may be connected by means of screw or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.
- Terminal shall be such that they cannot turn or be LM10 displaced when the connecting screws are tightened and such that the conductor can also not become displaced.
- Terminals should be so mounted that the appropriate wire may be connected without impairing the normal performance of the unit.

7.0 A.C. DISTRIBUTION BOARD SCHEME

Power will be fed to A.C. distribution board through 1 No. incoming 250 Amp MCCB from 100 KVA station service transformers. Suitable annunciation for failure of A.C supply is to be provided.

A 415 V single line diagram accommodating the above facilities and to suit the system is to be design and submitted to the Employer for approval. However, exact requirement layout is to be taken up by the contractor depending on the layout, rating and type of equipment for preparation of drawing.

7.1 PROTECTION SCHEME FOR INCOMING

The incoming circuit to the L.T. switchboard shall be provided by thermal overload relays, short circuit release and over current and earth fault protection.

D.C. operated audible as well as visible alarm with cancellation device shall be provided for the auto trip of the breakers.

7.2 CURRENT TRANSFORMERS

The current transformer to be provided with the incoming/outgoing circuit for metering shall be air-cooled of class 'CM' accuracy. The VA burden should be such as to suit the requirements. C.Ts shall be bar primary type moulded/cast resin type. The current transformer shall be manufactured and tested according to relevant I.S.S.

7.3 INSULATION LEVEL

The insulation at any point of the wiring in switchboards shall be suitable for 1100/660 volts grade service.

8.0 DC supply equipment

8.1 General scheme

The DC supply system (48V) shall comprise four nos. of battery each having 12V and battery charger, a dc distribution board and control gear. The system shall be arranged such that only one of the station batteries and one of the battery chargers

shall be in service at any one time, but should either item of equipment fail or need to be taken out of service for maintenance, then the duplicate item of equipment can be brought into service without disruption of supplies. Battery chargers shall be provided with an automatic change-over facility that will operate should one of the charger units fail.

The batteries shall be located in a battery room and connected to the distribution boards and battery charger located in an adjacent room via a fuse box located in the battery room.

Where the battery size is less than 100 Ah, and the cells are of the totally enclosed type, consideration will be given to housing the battery in a sheet steel cubicle mounted alongside the charger and distribution board so as to form a complete suite of panels.

The 48V DC power supplies system will operate with both battery terminals free of earth whilst that for communications equipment (the 50V DC power supply) will operate with the positive pole permanently earthed. A suitable earth fault detection scheme shall be provided.

The battery rated output shall be that available at the outgoing terminals, after making due allowance for the resistance of inter cell connections.

Earthing of current free metallic parts on the body of the distribution boards shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm² and the main earth bar for the distribution shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

The distribution board shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.

9.0 TECHNICAL SPECIFICATION FOR INDOOR TYPE 48 VOLT D.C. SYSTEM POWER DISTRIBUTION SWITCH BOARDS

9.1 SCOPE

This specification covers manufacture, assembly and testing at manufacturer's works, supply and delivery of Indoor Type 50 volts D.C. Power Distribution on Switchboards complete in all respects as per system requirement for 33/11 KV substation and switchyards. 20% spare feeders shall be provided in each DCDB.

9.2 STANDARDS

The equipment covered by this specification shall unless otherwise specified, be built to conform to Indian Electricity Rules 1956 wherever applicable. Permissible temperature rise shall be as per relevant ISS.

Switchboard Design

The switchboards shall be self supporting steel cubicle compartmentalized fully enclosed with doors for access to the interior. The switchboards shall comprise of non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear. The material & thickness of the sheet to be used as per the description above.

The complete panels shall not be more than 2250 mm. high with me channel base and 600 mm. depth measured from rear to front faces and of suitable width.

The working height shall be limited to maximum of 2000 mm. The design shall be such as to permit extension at site on either end. The bottom of the switchboard frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plants shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboards shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and oleos shall be covered with fine wire-mesh from inside or inbuilt type. All control and power cables will be paid in open distribution trenches running under the D.C. Switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The successful bidder shall furnish foundation drawings for the switchboards showing the cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates, grounding bolts, lock nuts, washers, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhering matter or grease. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing followed by application of an undercoat to serve as base and binder. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel, or dark battleship grey, evenly sparyed to present a fine appearance, while the interior faces shall be approved with a finishing coat of light grey paint to provide a contrasting background for the wiring inside the cubicle.

A small quantity of finishing paint shall be supplied with each consignment or the switchboards to enable the Employer to restore at site any surface finish which may get damaged during transit.

9.3 BUS BARS

The bus bar shall be of E.G. copper/aluminum alloy, liberally sized for the specified current rating (both short circuit and continuous currents). The size of bus bars shall be such that the current density is not more than

(1A/1.75A) per sq. mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying the positive and negative bus bars. Bus supports shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creep age surface.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/risers from or to the bus bars should not be twisted but reasonable bend or joint may be allowed.

9.4 MCCB & MCB

All incomer feeder will be provided with DC- MCCB(50 Amp) and all outgoing feeders with DC MCB (16 Amp) conforming to latest IS : standards as per system requirements.

9.5 FUSE

Fuses shall be HRC link type of renowned make conforming to latest issue of ISS 2208. Rewirable fuses shall not be supplied.

Fuse shall be complete with fuse bases and fittings of such design as to permit easy replacement of the fuse elements.

Link shall also be easily replaceable. Visible indication shall be provides on blowing of the fuse.

9.6 INDICATING LAMPS

Indicating lamps shall be LED type provided with suitable safety resistor and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover.

9.7 CABLE TERMINATION

Switch boards shall be designed to facilitate PVC cable entry from the bottom of the switchboard. Removable places shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029" copper conductor for control and for feeders up to 15 Amps. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with screws, nuts. Washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

Power terminal shall be complete with lugs and control terminals shall be clamp type. ScREW type terminals with screw directly impinging on conductor shall not be supplied. Connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the internal wiring and outgoing cables.

Each terminal for 25 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029" copper wires at one end without any damage to the connector or any looseness of connection. The terminals shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality.

9.8 WIRING

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be complete up to the terminal blocks at the factory. The insulation grade of wire to be used for internal wiring if the switch board shall be 1100 volts grade. Wiring shall be carried out with flexible heat resistant, switchboard wires PVC insulated with 2.5 sq.mm. stranded copper conductors.

Earth wire shall be identified at both ends with ferrules showing wire designations in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points.

Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminals, blocks, meters, relays, instruments and other devices used in the switchboards. Red ferrules with positive marking shall be used for positive terminals and white ferrule with negative marking shall be used for negative terminals for D.C. wiring.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination. All spare contacts of the equipment shall be wired up to the terminal block.

9.9 SAFETY EARTHING

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboards shall be done with soft drawn bare copper bus. Tail connections shall have minimum area of 26 sq. mm. and the main earth connection for each switchboards shall be brought out to two terminals for connection with the station earthing system.

Earth terminals should be identified by means of the sign marked in a legible and indelible manner on or adjacent to the terminals. Earth lugs shall be provided and all earthing connections shall be carried out with green wires.

9.10 SWITCH BOARD LIGHTING

The interior of each panel switchboard shall be illuminated by CFL lamps connected to 230 volts. Single phase A.C. supply and shall be controlled by a

door-operated switch. All A.C. wiring shall be carried out with black wires. The incoming A.C. supply to the D.C. boards shall be provided with H.R.C. fuse and link of proper rating.

9.11 INDICATING INSTRUMENTS

All instruments shall be of switchboard type, back-connected suitable for flush mounting. The construction shall conform to the appropriate Indian Standard Specifications. The instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. C to 50 deg. C. Those shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours.

9.12 COMPLETENESS OF SUPPLY

The switchboards offered by the bidder shall be complete in all respects. Any materials necessary which may not have been specifically mentioned but which is usual or necessary for satisfactory and trouble-free operation and maintenance of the switchboards shall be supplied without any extra charge to the Owner.

9.13 SPARES

The item wise price for the spares recommended for three years operation and maintenance of each switchboard shall be quoted.

9.14 INTER CHANGEABILITY

All similar materials and removable parts shall be interchangeable with each other.

All switches, contactors, etc. shall be easily removable as a complete unit from the switchboards and shall be capable of being put in similar position in other switchboards for performing identical functions.

The spares called for in respective sections shall be identical with like parts provided in the main equipments in all respects and shall be capable of replacing the main equipments wherever required to carry out identical functions.

10.0 ACCEPTABILITY OF DIFFERENT EQUIPMENTS & AUXILIARIES

All equipments, cables, wires and accessories offered shall be of best quality and of renowned make for successful and trouble free operation of the switchboards.

Equipments/accessories of substandard quality shall not be accepted by the Employer.

11.0 TESTS

The following tests are to be carried out.

- (i) Checking continuity of the wiring.
- (ii) Insulation resistance of all wiring circuit with all equipments mounted on the board, before and after application of H.V.

- (iii) One minute power frequency voltage withstand test. All equipments and wiring shall withstand a power frequency voltage of 2 KV applied between any circuit and earth.
- (iv) Routine test of all equipments, switches and devices according to relevant I.S.S.
- (v) Type test reports shall be furnished.

12.0 CLEARANCE

The apparatus forming part of the panel shall have requisite clearances and these shall be maintained during normal service conditions. When arranging the apparatus within the panels, the clearances for them shall be complied with taking into account the relevant service condition. In addition, abnormal conditions such as in short circuit shall not permanently reduce the distances between bus bars.

13.0 NAME PLATE OF D.C. SWITCHBOARDS

Each panel shall be provided with name plates, marked in a durable manner and located in a place such that they are visible and legible when the panel is installed. The following information should be given on the name plate.

- (i) The manufacturer's name and /or 'trade mark' & identification number.
- (ii) Rated operational voltage.
- (iii) Work order number and date.
- (iv) Weight.

14.0 Technical Specifications for CT console Box

The Box should be made out of CRCA steel duly painted having 3mm thickness suitable for outdoor type & complying with IP: 55.

The details size of the Box is as follows:

Height = 900mm
Width = 450mm
Breadth = 300mm

The CT console box having facilities of door for opening.

There shall be 3 rows of disconnecting type terminal blocks of Elmex / Connect well make, each row shall have minimum 15nos TB (should continuously carry minimum 20A & dia of the stud 6mm) with end plates.

There shall be provision of earth strips inside the Box (25x3mm thickness, Copper strips).

On the top of the Box, Connopy to be provided for easy drainage of water.

15.0 DETAILS OF DISTRIBUTION BOARDS.

15.1 ACDB:

a) Incomer - 1: 250 Amp MCCB, 50KA, provision of O/C & E/F, UV relay, ON/OFF lamp indication, Auto trip indication, R,Y,B healthy indication, Ammeter & voltmeter with selector switch, Annunciation facia with Acc, Reset and Test P.B.

- b) Out going Feeders: 1) 63 Amp MCB: 2 Nos,
2) 32 Amp MCB: 5 Nos,
3) 16 Amp MCB: 5 Nos
4) 100 Amp MCCB: 1 No (for transformer oil filtration)
& Spare compartment: 2 Nos.

15.2 LIGHTING DB (indoor & outdoor): R, Y, B Healthy Indication, Ammeter and voltmeter with selector switch.

- a) Incomer -1: 63 Amp MCB.
b) Out going feeder (for inc 1): 1) 32 Amp MCB: 5 Nos
2) 16 A MCB: 5 Nos

15.3 50 V DC Indoor Ltg. DB (for emergency purpose)

- a) Incomer : 32 Amp DC MCB from DCDB with auto changeover facility having delay timer with auto/manual selection switch.
b) Outgoing feeder: 16 Amp DC MCB: 4 Nos

15.4 50 V DCDB:

- a) 48 V DC DB: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

b) Incomer: 50 Amp DC MCCB:
c) Outgoing feeder: (1) 16 Amp DC MCB: 10 Nos.
(2) 32 Amp DC MCB: 1 No.